VEX ROBOTICS COMPETITION
OVER UNDER

KENNEDY GAELS 97140A

START:09.09.23 END:00.00.24

ENGINEERING NOTEBOOK

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Team Introduction

Kennedy Gaels Robotics Team 97140A has the success and legacy of competing in the VEX Robotics Competition for the last seven years. As students of John F. Kennedy Catholic Preparatory School, we strive for excellence, and maintain high standards in our Catholic faith. Founded in 2016 in our school's cafeteria, we won six awards including Tournament Finalists and Energy Award at our region's (Southern New York) State Championships with six members and no experience. Six years later, we expanded from our small beginnings and won over 45 awards, expanded our STEM program by getting our own workshop and reaching 14 members in 2021, and qualifying for the Vex World Championship yearly.

Each year, we are always proud of our team's achievements, small or large, and hopefully this year builds on that. Our motivation and drive is there, powered by wanting to do better and better from the previous season based off of achievements and performance.

On September 16, 2023, the Kennedy Gaels team 97140A started their 2023-2024 journey to the Vex Robotics Competition Season. Our team this year consists of four members: Matthew Achim, John Pollack, Lazaro Hidalgo, and Brenna Rosario- A group with varying ranges of experience and no shortage of excitement for the game. In addition to the team specific roles and responsibilities, the entire team is responsible for scouting as well as building.

Fun fact: Hex Code #97140A is actually a dark red color!

As VEX Robotics enthusiasts, our team mission is valued on three main objectives: Integrity, Respect, and Perseverance.

I. Integrity is illustrated throughout our team, from the inception of the robot build to each competition, win or lose. During tournament interviews, we equally contribute towards answering the judge's questions. Our drive teams collaborate together and strategize on and off the field.

II. Respect is key for our team. From the workroom to the field, we honor and respect our competitors, our allies, and most importantly, the new friendships made.

III. Teamwork and communication help us persevere through any challenge we come across. After each competition, we go back to the drawing board and solve those issues and work around the barriers.

This season, our GOAL is to return to the VEX Robotics World Championship!
With hardwork and perseverance, we can do it!

Meet The Team

Matt Achim

About Me

Hi I'm Matthew, and my nickname is Matt. I'm a senior at Kennedy and the captain of 97140A. I have been doing robotics since middle school due to the influence of my older brother.

Team History

My love for robotics started in middle school as I followed in my older brothers footsteps. When I joined the team at Kennedy, I became captain of Team A. I have been captain ever since, and this is my fourth year as captain.

My Favorites

- Video games
- Buying and working on cars
- Swimming
- Listening to music

Competitions

At competitions you will always find me on the field, as I am the driver. If not, I'll likely be in the pits, tinkering with the robot, or at skills trying to get my score up.

Name: Brenna Rosario
Date: 9/9/23
Project Name: Meet The Team
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Meet The Team

John Pollack

About Me

Hi I'm John. Im a senior at Kennedy and the co-captain on Team A. I have been doing robotics since freshman year.

Team History

i have been on the team as an engineer since my freshman year. I enjoy robotics and hope to study engineering in the future.

Favorites

- Building Legos
- Playing video games
- Star Wars
- My dog

Competitions

At competitions, I'm always on driveteam. If not, I'll be running back to the pit for a battery or waiting on line for skills.

Name: Brenna Rosario
Date: 9/9/23
Project Name: Meet The Team
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

MEET THE TEAM

Brenna Rosario

ABOUT ME

Hiii! My name is Brenna, and I'm a junior in the honors program at Kennedy. I have been doing robotics since freshman year and I hope to pursue Environmental or Oceanographic Engineering.

MY FAVORITES

- I love watching movies, especially Harry Potter.
- I'm interested in graphic design
- Science and art fascinate me.
- The aquarium is one of my favorite places to be.
- I enjoy hiking in my spare time.

MY TEAM HISTORY

I started on robotics as freshman as a journalist and co-engineer on Team C. I held the same positions last year on Team B.

This year, I am the lead journalist on Team A, and have been consistently working on improving my journaling, design, and art within robotics.

AT COMPETITIONS

At competitions you can frequently find me scouting other teams and talking to people. During a match, if I'm not on drive team, I'll be on the sidelines taking pictures.

Name: Brenna Rosario
Date: 9/9/23
Project Name: Meet The Team
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Meet The Team

About Me

Hi, I’m Lazaro, and my nickname is Laz. I am a junior at Kennedy and have been on the team since my freshman year.

Team History

I have been on team 97140A since my freshman year. I am one of the engineers on the team, and am known as “Mechanical Jesus.”

At Competitions

At competitions you will typically find me on drive team or waiting on line for skills. If you can’t find me in either of those places I’ll be running back to the pit for a battery.

My Favorites

Name: Brenna Rosario
Date: 9/9/23
Project Name: Meet The Team
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Welcome to the New Season

Today's Goals:

1. Unpack boxes
2. Set up field
3. Create teams
4. Outline plan for the new year
5. Team overview and history

Who Was Here:

- Matt
- John
- Brenna
- Lazaro

Date and Time: 9/9/23, 10am-4pm

The meeting commenced with the establishment of new teams, due to our abundance of resources and team members this year, enabling us to form three distinct teams. We reconfigured the composition of each team to put together people that worked best. We also made sure to pair new members with teams that had experience to ensure everyone will learn throughout the year. Over the course of the summer, our robotics room underwent a comprehensive renovation, causing the relocation of all our equipment and supplies to an alternative space. This involved a full-day endeavor of packing, moving, unpacking, and reorganizing our inventory, as we shifted it from its former storage location in the computer lab to the newly refurbished robotics room.

The renovation not only transformed the robotics room but also the adjacent area into a cutting-edge STEM lab. This upgrade brought about significant improvements, including the installation of new shelving, tables, and state-of-the-art equipment. Furthermore, our newly acquired space provided us with a more accommodating and conducive environment for our activities.

We established rules for the year and looked back on our past accomplishments. The coaches and new members in particular enjoyed seeing our progression into the team we are today.

Welcome to the New Season:
Team Schedule

Meeting Location:

Kennedy Catholic Preparatory School
54 NY-138
Somers, New York 10589

Classroom 128 - Journal and Computer Lab
Classroom 129 - Robotics Workshop

@gaels97140

www.linktr.ee/kcrobotics

Meeting Dates:

September to April:

- ★ Saturdays 10:00AM to 4:00PM
- ★ Sundays 12:00PM to 4:00PM

We meet on occasional days during week after school and “build nights” with our friends at The Harvey School; More frequent meetings if necessary before competitions.

Welcome to the New Season:
Team History

- 6 Members
- Robot Skills Champion
- Judges Award 3x
- Qualified & Competed at Southern New York State Championship
- Tournament Finalists and Energy Award at Southern New York State Championship
- Qualified & Competed at Vex World Championship as a brand new first-year team.

- 8 Members
- Tournament Champions
- Tournament Finalists
- Robot Skills Champion
- Judges Award
- Qualified & Competed at Southern New York State Championship
- Excellence Award at Southern New York State Championship
- Qualified & Competed at Vex World Cha,mpionship
- Energy Award at Vex Robotics World Championship

- 6 Members
- Excellence Award
- Tournament Champions
- Robot Skills Champion 3x
- Sportsmanship Award
- Qualified & Competed at Southern New York State Championship
- Excellence Award at Southern New York State Championship
- Qualified & Competed at Vex Robotics World Championship
- 9th Place in Our Division

Welcome to the New Season: Team History_

- 5 Members
- Excellence Award
- Tournament Finalists 3x
- Design Award 3x
- Judges Award
- Innovate Award
- Qualified & Competed at Southern New York State Championship
- Amaze Award at Southern New York State Championship
- Qualified for Vex Robotics World Championship

- 4 Members
- Excellence Award 2x
- Robot Skills Champion 4x
- Judges Award
- Tournament Champions
- Qualified & Competed at Southern New York State Championship
- Southern New York State Champions
- Qualified & Competed at Vex Robotics Remote World Championship
- 13th Place in Our Division

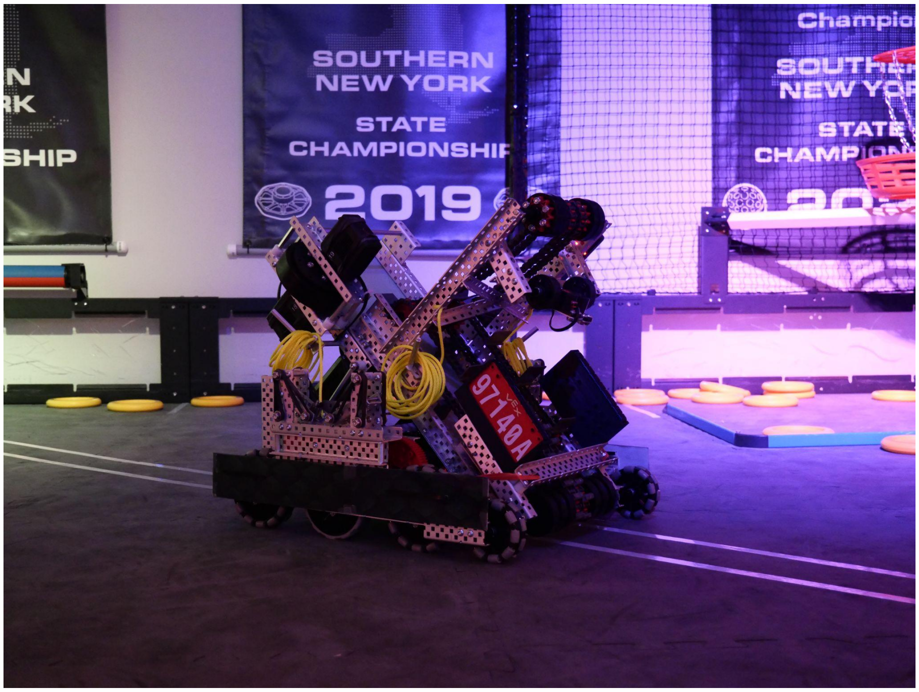
- 14 members
- Tournament Finalists 3x
- Robot Skills Champion
- Design Award
- Build Award
- Sportsmanship Award
- Tournament Champions
- Amaze Award
- Qualified & Competed at Southern New York State Championship
- Create Award at Southern New York State Championship
- Two Teams Qualified & Competed at Vex Robotics World Championship
- 6th Place in Our Division
- Energy Award at Vex Robotics World Championship

Welcome to the New Season:
Team History

2022-2023

Spin Up

- 12 Members
- Southern New York State Excellence Award Winners
- Qualified for VEX Robotics World Championship
- 4X Excellence Award Winners
- 2X Design Award Winners
- 2X Tournament Champions
- 1X Create Award Winners
- 1X Tournament Finalists
- 2X Sportsmanship Award Winners
- Division Quarter Finalists at Worlds



Welcome to the New Season: Safety Rules for Workshop

Every team member and their parent were required to sign this Robotics Workshop Safety Rules Pledge so they acknowledged they will follow the rules of the workshop. This was to ensure we were all being cautious when using tools in our room.

1. Obtain an adult mentor's permission before operating any machinery, hand or power tool. Students must not operate any machinery or perform any "cuts" of metal without notifying a mentor first. Machinery and tools include: Dremel, power chop saw, drill press, hand drill, oscillating tool, grinder, hack saw, etc.
2. Do not use any tools or equipment without proper safety and use instruction. Refrain from "fiddling" or playing with things that are lying out.
3. Safety glasses must be worn when machines, tools and robots are in use including for the operator and bystanders.
4. Concentrate on the task at hand and avoid being distracted by other activities. Conversely, avoid distracting others.
5. No running, boisterous behavior or horseplay in the Robotics Workshop.
6. Clothing and jewelry must not be worn that could become caught in equipment. Long hair should be properly secured so it doesn't get caught in machines or robots.
7. Tools and equipment should only be used in the manner in which they are intended.
8. Never test a tool for sharpness by touching its edge.
9. Do not use a machine or power tool if you have not been shown how to operate it safely by an adult mentor.
10. Keep your workbench tidy. When you have finished with a tool or piece of equipment, return it to its place.
11. Keep fingers away from any moving parts of your robot.
12. Beware of pinch points. A pinch point is any point at which it is possible for a body part to be caught between moving or stationary parts of the robot.
13. File or sand all sharp edges.
14. Help keep the Robotics rooms clean! All equipment, tools and hardware must be properly stored before the end of the Robotics Meetings.

Welcome to the New Season:

Planning for the Season

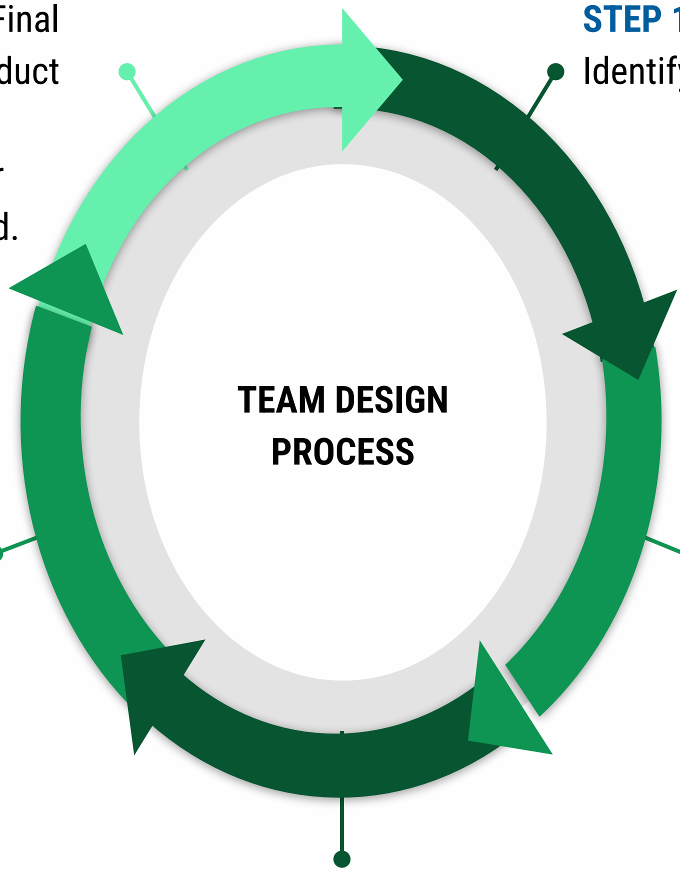
September	October	November
Complete the basic parts of the robot, including chassis, catapult, conveyor and more. Through trial and error continue to build and mount all required pieces to have a successful robot this season.	Continue to troubleshoot any issues we have, improve on old or inefficient designs, continue to have multiple versions of the robot in order to build upon it. Create driving paths as well as end-game strategies. Look at past competitions to see strategies already in use.	Improve on our robot in preparation for competition, create autonomous and improve as needed, and practice driving to see if there are any issues as well as create strategies for matches.

December	January	February and on
Test robot at first competitions. Decide if robot requires complete rebuild or iteration to certain parts. If entire new design and build, prepare to rebuild over holiday break.	Test new robot or iterated robot at competitions. Continue troubleshooting. Improve Skills Score including Skills coding autonomous to rank high on leader board.	Continue to compete. Observe what more can be done to remain competitive in New York state. Prepare for State Championships.

Welcome to the New Season:
Engineering Design Process

STEP 5 - Refine Final Product
Includes making changes until our problem is solved.

STEP 1 - Identify
Identify our problem



STEP 4 - Testing and Building
Testing out a certain solution to our problem, seeing if it works the best and using it.

STEP 2 - Research
Research the best possible solutions.

STEP 3 - Solutions
Present options, pros and cons, and create a decision matrix scored relatively to each option comparatively.

Welcome to the New Season:
Engineering Design Process

The engineering design system process is a systematic approach to solving problems and creating new products, systems, and structures. It is a process that we as a team use to guide us through the problem-solving process, from identifying a problem to creating and testing a solution. The process is typically divided into several steps that are followed in a specific order. The following is a more detailed explanation of each step of our engineering design process:

Step 1: Identify the Problem
The first step in the engineering design process is to identify the problem, or need that needs to be addressed. This step requires us to clearly define the problem/challenge, understand the restraints and requirements, and gather information about the current state of the problem. We must be able to understand the problem from multiple perspectives, to ensure that we are addressing the root of the problem.

Step 2: Research and Analysis
The next step in the engineering design process is to conduct research and analysis. This step involves gathering information and analyzing data to understand the problem and identify potential solutions. We must be able to critically evaluate the information we collect and use it to identify the best solutions. This step is also important for identifying possible constraints, such as time and material constraints, that may impact the final solution.

Step 3: Generate Possible Solutions
Once the problem has been identified and analyzed, the next step is to generate possible solutions. We must be able to think creatively and and come up with multiple potential solutions. We must also be able to evaluate each solution based on certain criterias suich as feasibility and effectiveness. This step involves **creating a decision matrix** that scores each option comparatively, so that the best solution can be chosen.

Step 4: Testing and Building
The fourth step in the engineering design process is to test and build a prototype of the chosen solution. We must be able to design and construct a functional prototype that can be tested to see if it solves the problem. This step requires us to have strong technical skills, as well as experience with the materials and tools necessary to build the prototype. It also requires us to be able to work with other team members to ensure that the prototype is built according to the specifications.

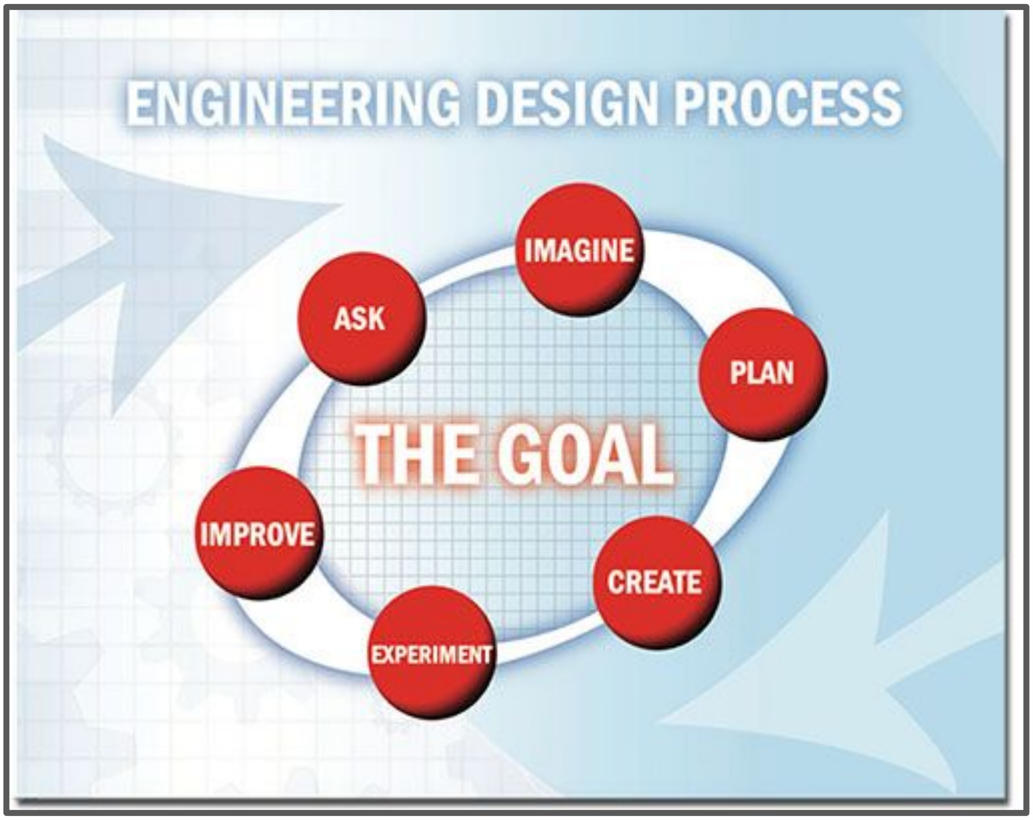
Step 5: Refine the Final Product
The final step in the engineering design process is to refine the final product. This step involves making adjustments and improvements to the product based on testing and feedback.

Welcome to the New Season:
Engineering Design Process

We must be able to identify any issues that need to be addressed and make changes to the product as needed. This step may also involve working with other team members to ensure that the final product is of high quality and solves the challenge of the game.

In summary, the engineering design process is a systematic approach to solving problems and creating new pieces, systems, and structures. It is a process that we as a robotics team use to guide us through the problem-solving process, from identifying a problem to creating and testing a possible solution. The process is typically divided into several steps that are followed in a specific order. The process is designed to be a iterative and cyclical, which feedbacks from previous stages influencing the next stages.

The goal is to find the most feasible solution for a given problem, taking into account the constraints and requirements. It is a process that allows us to think creatively, work collaboratively, and usee our technical skills to design and build new constructs.



Welcome to the New Season:

Setting up and creating new teams

The main goal of our first meeting was to get set up for the new year. Our room was renovated, and during it all of our tools and supplies were put into boxes in a separate room. To do so, we split into 3 separate teams. One group went through boxes to determine what we had and were missing. The second reorganized our materials, and the third began setting up the field. This allowed us to have our room set up by the end of the day in an efficient manner.

Since we got two new members and have five seniors we created new teams. We decided to split into three different groups. We tried to base if off of members individual skills such as journal, building, and programming.

Name: Brenna Rosario
Date: 9/9/23
Project Name: Welcome to the New Season
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Robot Design Ideas and Game Analysis

Today's Goals:

1. Brainstorm robot design ideas
2. Finalize Team
3. Watch past competition videos (Mall of America)
4. Compare and contrast designs
5. Learn how game works

Who was here:

- Matt
- John
- Brenna

Time and date: 9/10/23, 12pm-4pm

To commence today's meeting, we began watching competition videos. Our primary focus was on the Mall of America competition, with particular emphasis on the quarterfinals and beyond. The objective was to discern recurring trends among the top-performing robots. During this analysis, a pattern emerged, revealing that the majority of victorious teams used a catapult mechanism.

Additionally, our observations extended to identifying potential autonomous period skills that could be integrated into our programming such as bit and tri-ball positioning.. This not only broadened our knowledge but also provided a strategic advantage for our team.

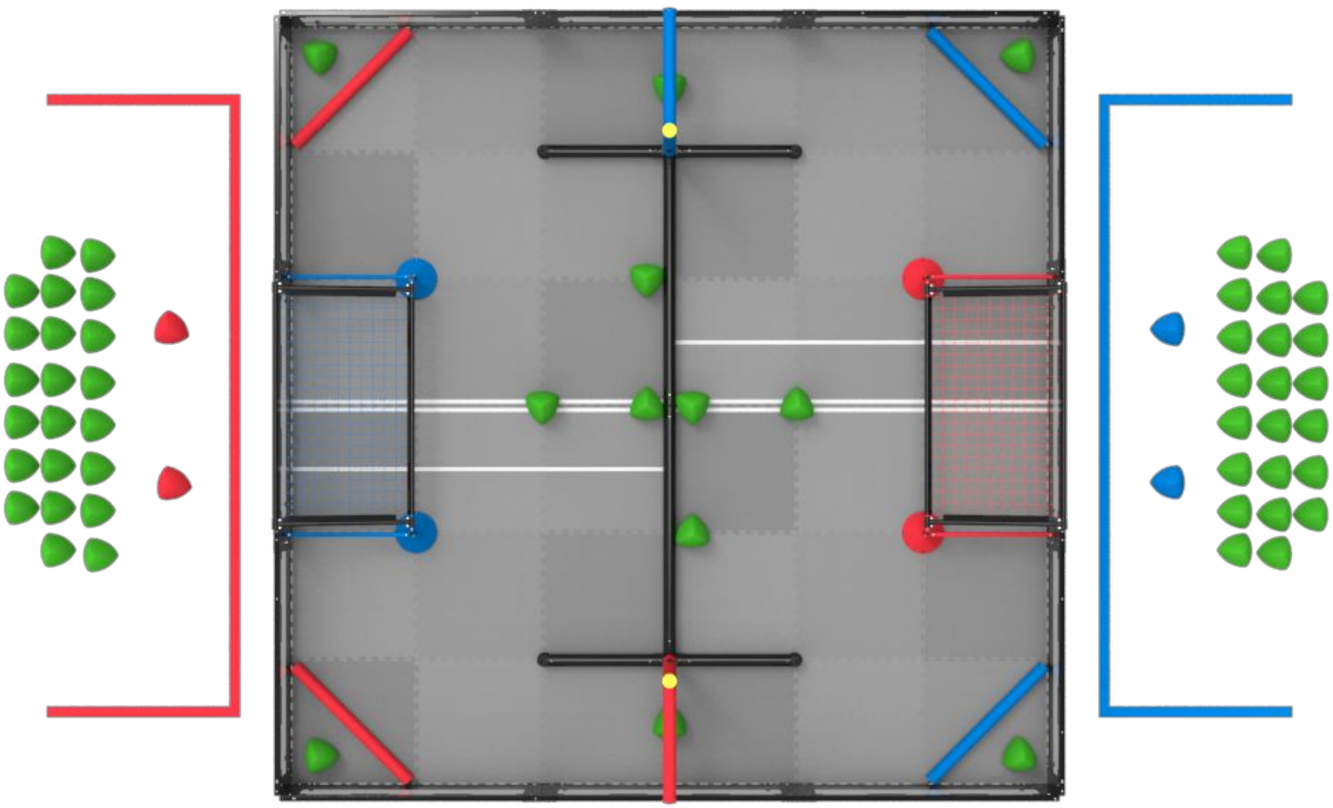
We also overviewed the intricate game rules and scoring system, ensuring that we are well-versed in the regulations of the competition. This knowledge is invaluable as it guides our decision-making and planning.

We ended the meeting by sketching and brainstorming various robot design concepts, and discussing which choice would create the best robot.

Robot Design Ideas and Game Analysis

VEX Robotics Competition Over Under is played on a 12' x 12' square field configured as seen above. Two (2) Alliances – one (1) "red" and one (1) "blue" – composed of two (2) Teams each, compete in matches consisting of a fifteen (15) second Autonomous Period, followed by a one minute and forty-five second (1:45) Driver Controlled Period.

The object of the game is to attain a higher score than the opposing Alliance by Scoring **Triballs** in **Goals**, and by **Elevating** at the end of the Match.



Robot Design Ideas and Game Analysis

There are sixty (60) **Triballs** on a VRC Over Under Field.

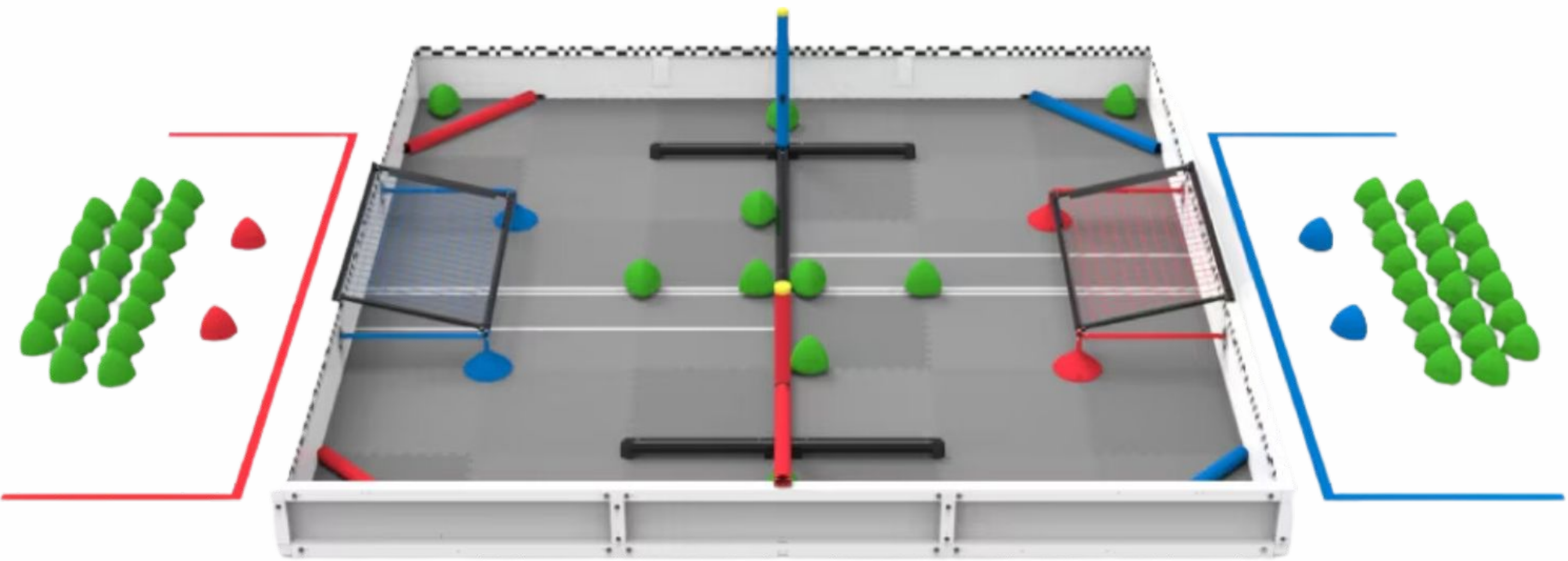
There are two netted **Goals** on opposite sides of the field. A 2” PVC **Barrier** divides the field into a Red **Offensive Zone** and a Blue Offensive Zone.

Each Triball scored in a Goal is worth five (5) points, and each Triball which makes it into an Offensive Zone is worth two (2) points.

The VRC Over Under Field also includes two sets of Alliance-specific pipes on either side of the Barrier. These are called **Elevation Bars**, and are used at the end of the Match for **Elevating** Robots.

At the end of the Match, each Robot’s height off the ground will be measured to determine their **Elevation Tier**. Elevation Points will then be awarded based on each Robot’s Tier *relative* to all other Robots. For example, getting to Tier E could be worth as many as twenty (20) points OR as few as five (5). Elevation Tiers begin at the floor, and they end above the Elevation Bar!

The Alliance that scores more points in the Autonomous period is awarded with eight (8) bonus points, added to the final score at the end of the match. Each Alliance also has the opportunity to earn an **Autonomous Win Point** by completing three assigned tasks. This Bonus can be earned by both Alliances, regardless of who wins the Autonomous Bonus.



Robot Design Ideas and Game Analysis

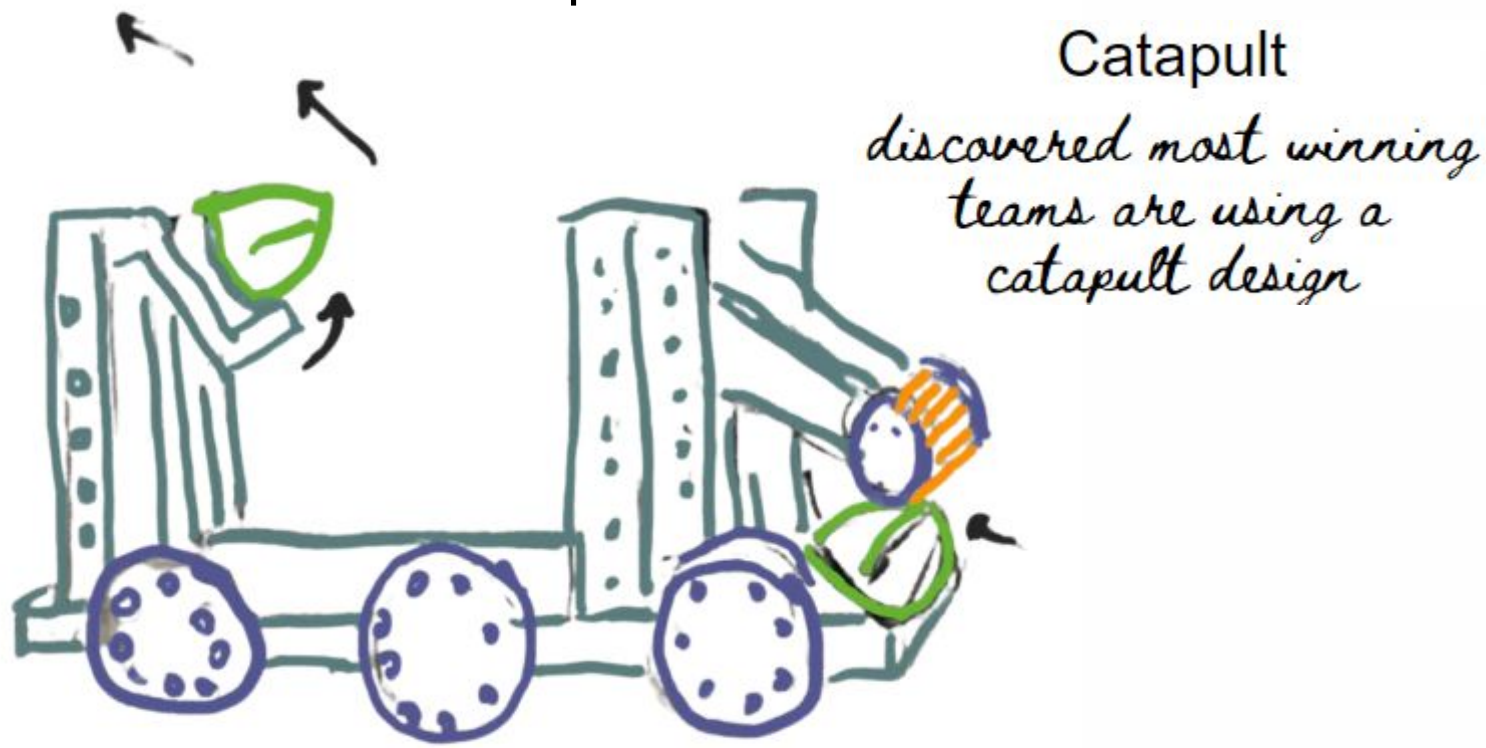
Autonomous Bonus	**8 Points**
Each Triball Scored in a Goal	**5 Points**
Each Triball Scored in an Offensive Zone	**2 Points**
Elevation- Top Tier	**20 Points**
Elevation- 2nd Tier	**15 Points**
Elevation- 3rd Tier	**10 Points**
Elevation- 4th Tier	**5 Points**

The scoring of this game seems simple on paper, but can become more complicated depending on the mach. One of the main questions our team had was: What counts as a scored triball (under the net)?

After watching different videos, we found one from VEX that explained this exact question. According to VEX, if at least two corner of a triball are under the net, it counts as scored.

Robot Design Ideas and Game Analysis:

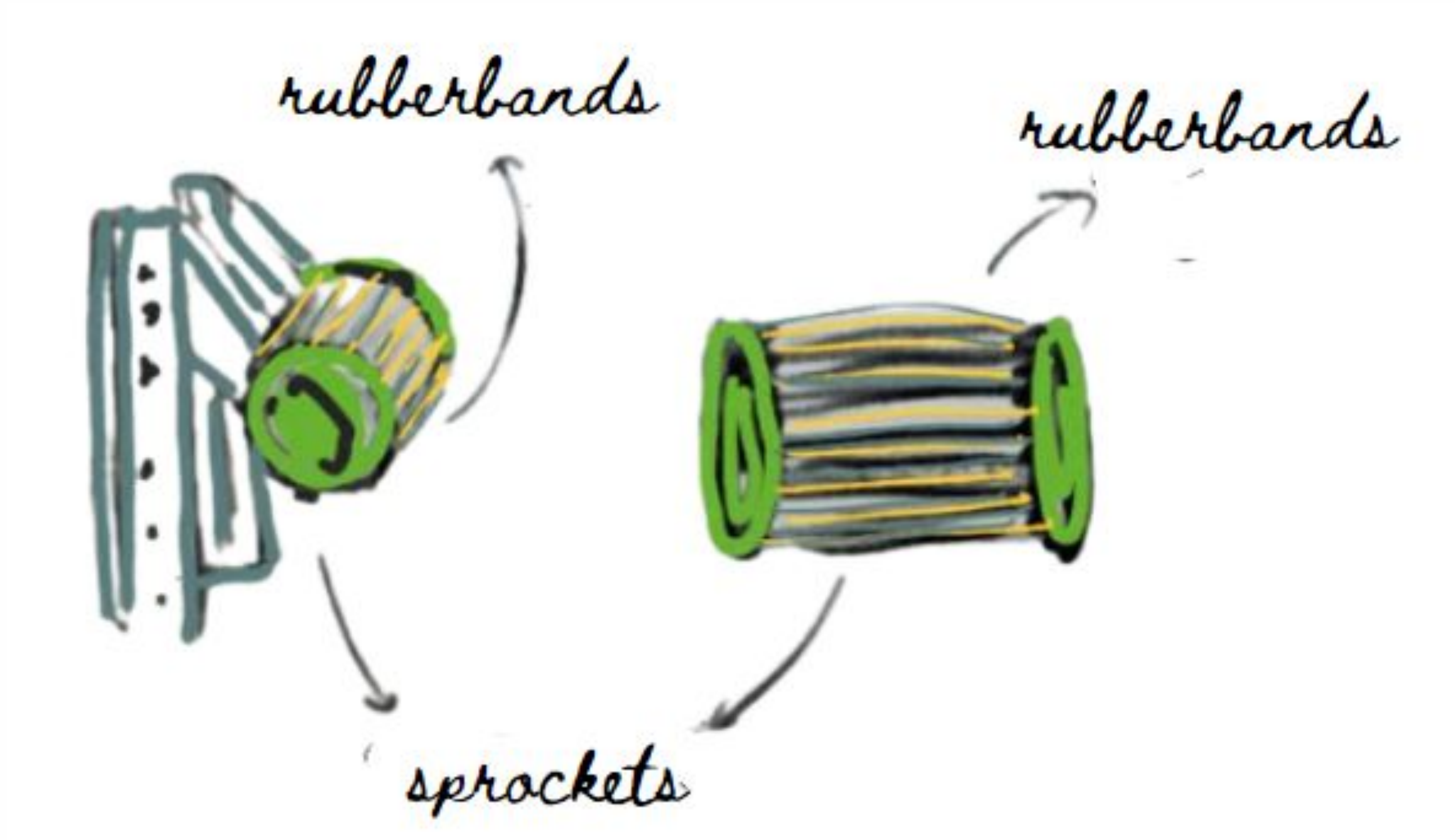
Catapult Possible Solutions



As we began our research by studying game videos, a trend began to emerge. It became increasingly apparent that some of the most accomplished and successful teams in the competition, those who had reached the finals or semifinals, had adopted the catapult design as their strategy. The catapult design boasts several intriguing variations. Recognizing the versatility that this particular design offers, we have made it a pivotal part of our strategy.

The allure of the catapult design lies in its ability to propel game elements, such as triballs, over impressive distances in a fraction of a second. This rapid-fire capability has the potential to set us apart as a formidable competitor. When coupled with a swift intake mechanism, our robot would become a well-oiled machine, capable of quickly and efficiently gathering game elements and propelling them towards our targets. This synergy between the catapult and the intake holds the promise of making our robot one of the fastest on the field. Our skilled driver, Matt, has a preference for speedy robots, which aligns perfectly with our chosen design. Matt's adeptness at handling agile and quick machines makes him an invaluable asset to our team. His extensive experience has honed his driving skills to synchronize seamlessly with this style of robot.

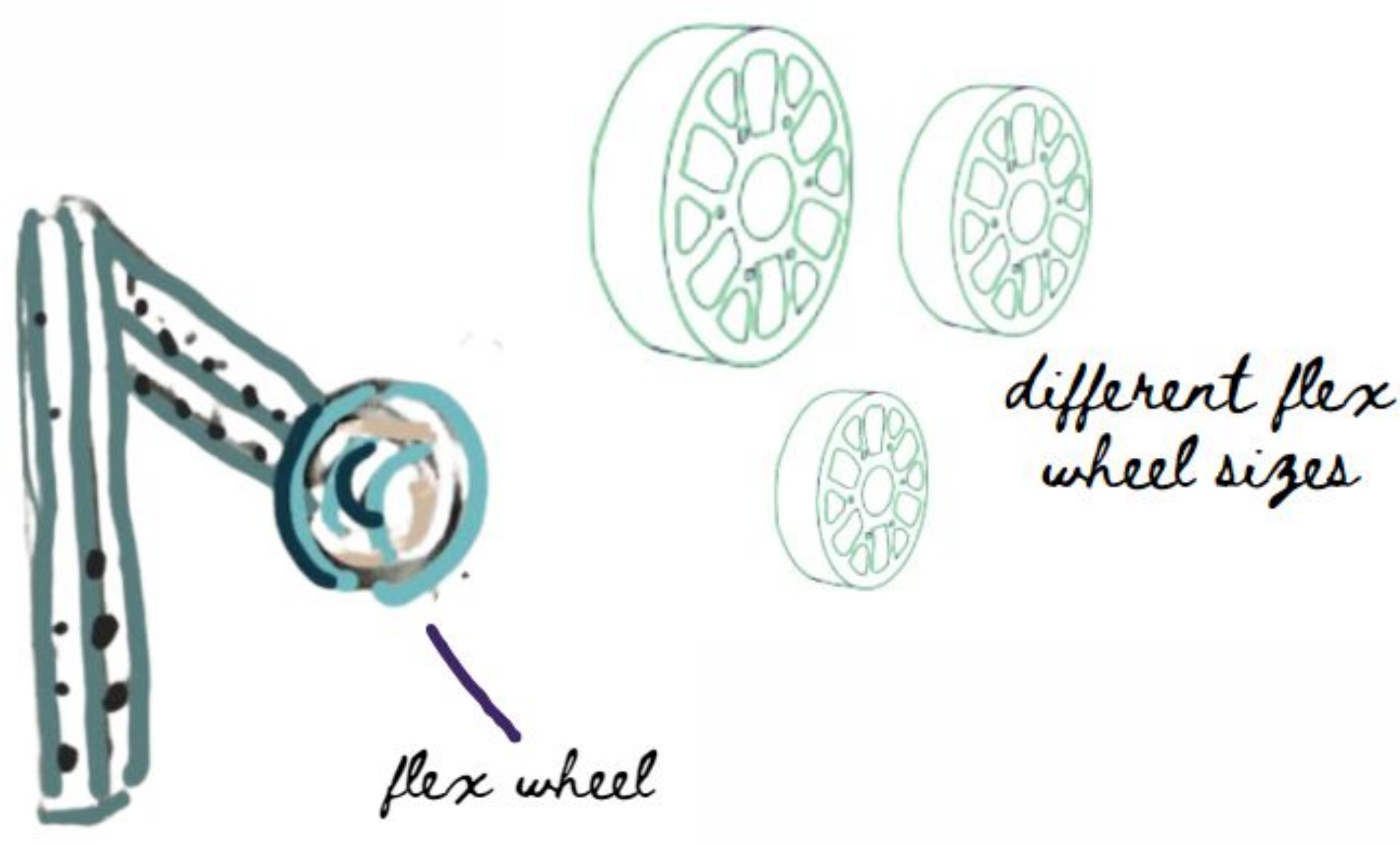
Robot Design Ideas and Game Analysis:
Intake Possible Solutions



Our team is actively exploring two intake designs to complement our overarching strategy of integrating a catapult mechanism into our robot. This synergy aims to create a robot that is not only fast but also powerful. A critical driving factor behind the need for an efficient intake system is the unique size and shape of the tri-balls used in the competition. These intake systems are essential for swiftly and effectively gathering these game elements and facilitating their precise propulsion by the catapult.

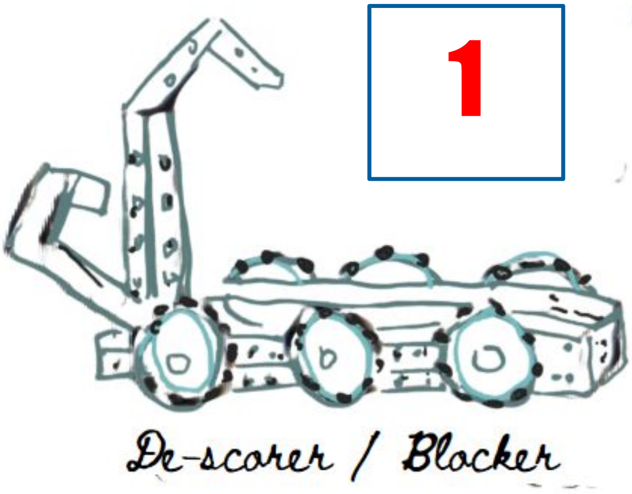
Robot Design Ideas and Game Analysis:
Intake Possible Solutions

The selection of the optimal intake design involves a careful evaluation of several key factors. These include the tri-ball's shape and size, the need for speed, the intake system's location on the robot, and its ability to efficiently pre-load game elements. Additionally, we must consider the use of various sizes of flex wheels to enhance our intake capabilities. These considerations go back to our commitment to innovation and excellence as we strive to create a competitive robot that excels in this challenging game.



Robot Design Ideas and Game Analysis:
Overall Design Possible Solutions

1



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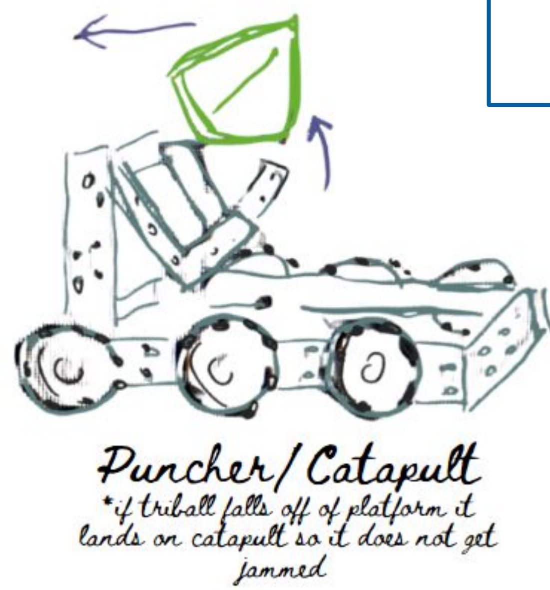
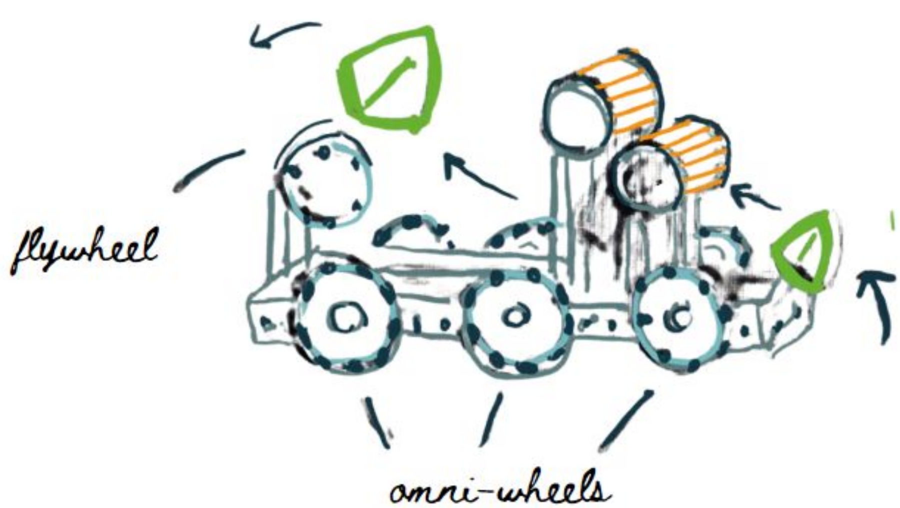
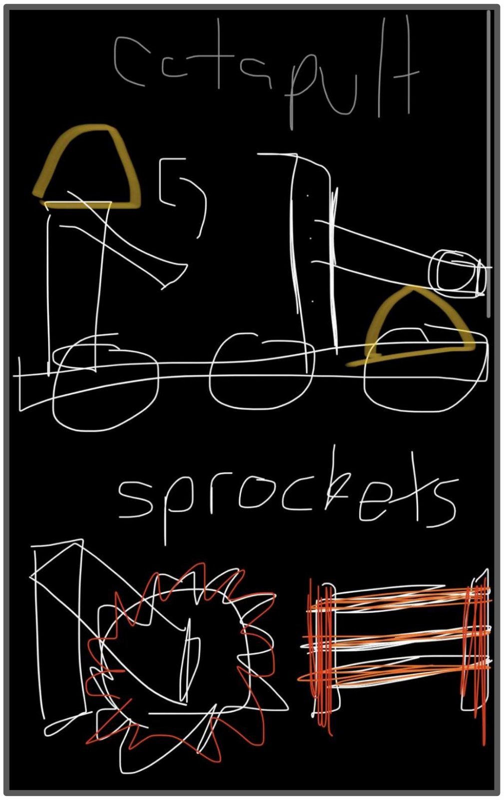


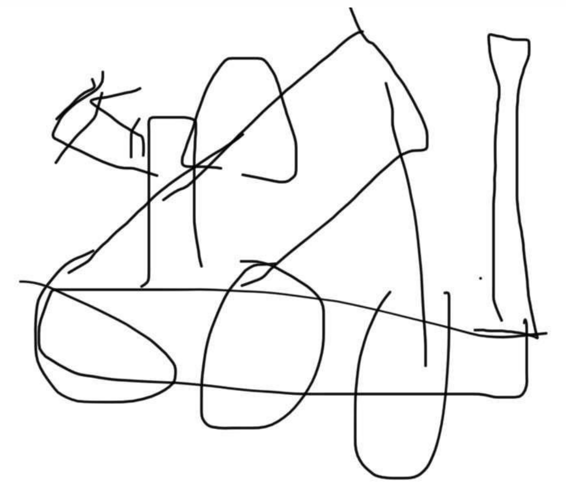
These are additional design choices we are considering. The descorer/blocker has been effective in most of the matches we watched, however, since it is not as prevalent as the catapult or intake, it will be added on in later meetings. The puncher/catapult design information has been useful in preventing a tri-ball from getting jammed if it falls off the platform. A final consideration is wheel choice. Although this is debated year by year, we typically use omni wheels. This is Matt's favorite, as it allows him to strafe and quickly maneuver around the field.

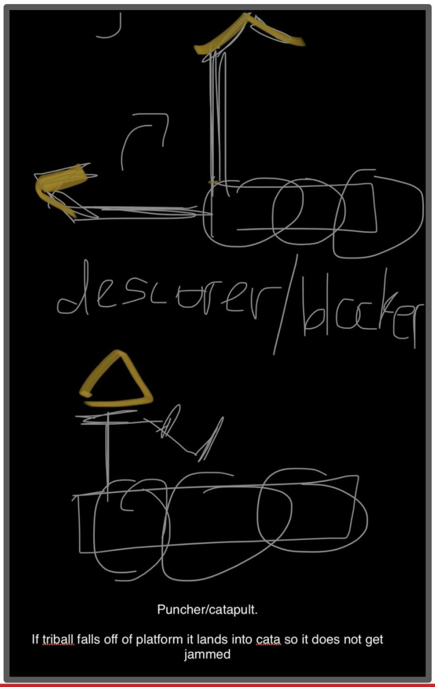
3



Robot Design Ideas and Game Analysis:
Original Design Idea Sketches







Robot Design Ideas and Game Analysis:
Design Inspiration

Mall of America Observations

We watched the Mall of America* signature event (August 2023), to find innovative ideas We found that teams employed various strategies including catapults, flywheels, and simples pusher bots. One particularly intriguing concept that captured our attention was the implementation of a blocker/descorer mechanism. This unique approach demonstrated the potential to touch the corners of the field, a crucial maneuver that allows a team to position themselves closer to the center while employing a catapult to propel game loads across the expanse. This proximity to the middle is indispensable as it enables precise placement of match loads onto the corner, a requirement for successful gameplay.

Decision Matrix Brainstorming

Decision Matrix

Flywheel vs Catapult

	Flywheel	Catapult
Accuracy	3	4
Effectiveness	3	4
Speed	3	5
Weight	2	4
Build Complexity	3	3
Programming	3	3
Total	17	23

Source: MOA Signature Event https://www.youtube.com/watch?v=p2VNsDSI720

Name: Brenna Rosario
Date: 9/10/23
Project Name: Robot Design Ideas and Game Analysis
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Robot Design Ideas and Game Analysis: Decision Matrices

Claw vs Top Roller vs Side Roller

Decision Matrix

	Claw	Top Roller	Side Roller
Accuracy	3	4	2
Effectiveness	3	4	2
Speed	2	5	3
Weight	1	4	4
Build Complexity	3	3	2
Programming	3	4	2
Total	15	24	18

Crawling on bar vs Claw to pull up on vertical bar vs Hanger for horizontal bar

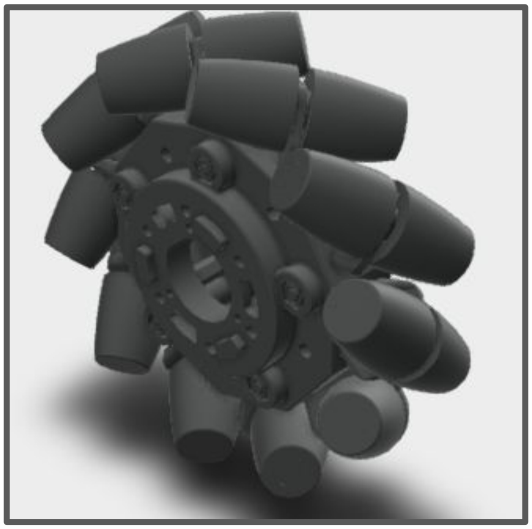
Decision Matrix

	Crawling on bar	Claw to pull up on vertical bar	Hanger for horizontal bar
Accuracy	4	4	4
Effectiveness	3	4	2
Speed	2	5	3
Weight	2	3	4
Build Complexity	3	3	3
Programming	4	2	4
Total	16	22	23

Robot Design Ideas and Game Analysis:
Decision Matrices

Decision Matrix- Mecanum (4 wheel), Omni (4 motor), Omni (6 motor) Decision Matrix

	Mecanum (4 Wheel)	Omni (4 Motor)	Omni (6 Motor)
Accuracy	2	5	2
Effectiveness	3	4	2
Speed	2	5	3
Weight	3	4	4
Build Complexity	2	3	1
Programming	3	4	2
Total	12	25	17



6in Mecanum

6in Omni

Robot Parts and Chassis Design

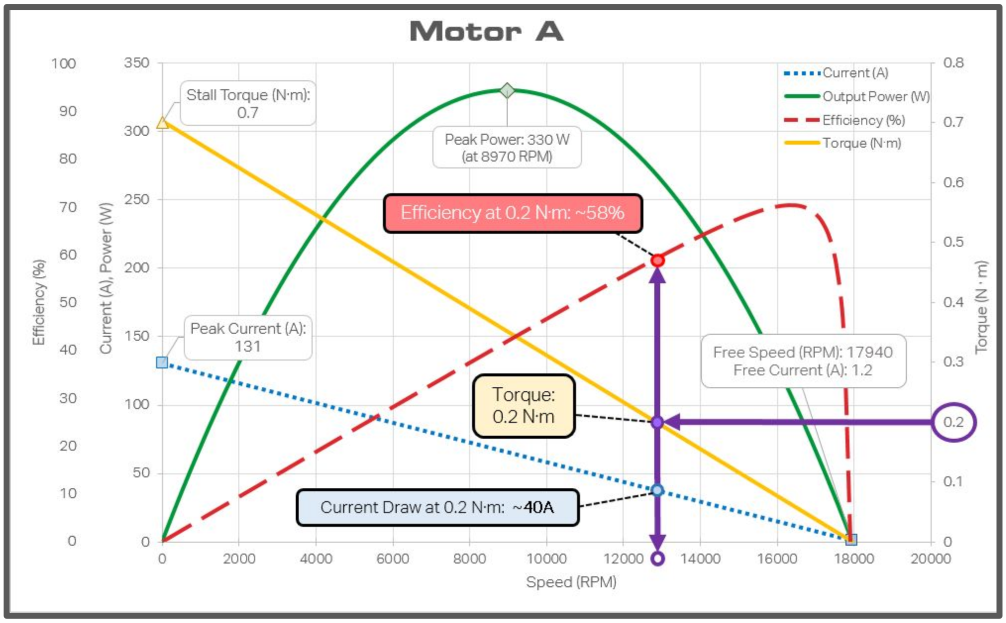
Today's Goals:

1. Decide on robot speed/ RPM
2. Begin chassis

Who was here:

- Matt
- John
- Brenna
- Lazaro

Time and date: 9/16/23, 10am-4pm



Our meeting kicked off with discussing gear ratios and RPM. We spoke about the different motors, and their cartridges, and explored the way they would alter our robot's performance. The discussion naturally led us to explore the concept of revolutions per minute (RPM), another important factor in the creation of our robot.

As the day unfolded, we transitioned into an analysis of chassis design options, contemplating the critical decisions that would influence our robot's mobility and structural integrity.We compared the pros and cons associated with each possible shape and size.

We constructed the six wheels that would serve as the foundational base for our robot. In the end, we arrived at a final chassis design that aligned with our vision for the robot, making sure it met our performance and strategic objectives.

Robot Parts and Chassis Design:
Motors

The EXP Smart Motor (5.5W) is capable of producing half the power of the original V5 Smart Motor (11W). Perfect for low-RPM or lightweight applications such as indexers, arms, or some intakes.

Note: This motor operates at a set RPM, and is *not* compatible with V5 Smart Motor cartridges.

The V5 Smart Motor is more than twice as powerful as the 2-Wire motor 393, and puts an integrated encoder and a motor controller into one compact package. Customize speed and torque with interchangeable gear cartridges.

- Use the built-in encoder to track a robot's rotational position and velocity
- Compatible with both VEX V5 shaft sizes

The motor runs at a slightly lower voltage than the batteries minimum voltage, and the motor's power is accurately controlled to +/-1%. This means the motor will perform the same for every match and every autonomous run regardless of battery charge or motor temperature.

Mechanisms such as flywheels and arms do not need large external gear ratios when the driving motor is already outputting a targeted output speed or torque. Therefore, changing internal gear ratios to fit specific needs allows more efficient and compact mechanisms to be designed. Use the clear window of the V5 Smart Motor to identify one of three user-changeable colored gear cartridges:

36:1 (100 RPM) - High torque, low speed. Great for robot arms and lifting heavy objects

18:1 (200 RPM) - Standard gear ratio for drive train applications

6:1 (600 RPM) - Low torque, high speed. Best used for intake rollers, flywheels, or other fast moving mechanisms

Source: Home - VEX Robotics

Name: Brenna Rosario
Date: 9/16/23
Project Name: Robot Parts and Chassis Design
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Robot Parts and Chassis Design:
Gears and Gear Ratios

Gears:

All V5 gears are 24DP, which means there are 24 teeth per inch of pitch diameter. So a 12T gear would have a pitch diameter of 1/2" (12T / 24DP). The 24T gear would have a pitch diameter of 1".

The pitch diameter of all the V5 gears are:

12T = 0.5" Pitch Diameter

24T = 1.0" PD

36T = 1.5" PD

48T = 2.0" PD

60T = 2.5" PD

72T = 3.0" PD

84T = 3.5" PD

To work with the existing holes in Vex metal, the radii (not the diameters) of two gears have to add to a multiple of 0.5".

12T + 36T radii add to 1.0", or two holes apart.

12T + 24T gives you 0.75", which will be halfway between two holes.

Gear ratio is the relationship between the circumference of the gear on the driven part and the circumference of the gear on the driving part (motor). When several gears are meshing together, they form what's called a gear chain. The ratio is only calculated from the first gear (the driven gear) and the last gear in the chain, which is the driving gear, the one attached to the motor. The ratio represents the increase in torque (and the proportional decrease in velocity)

Source: carminebot.com/vex/v5/vex_gears.txt

Robot Parts and Chassis Design:
Gears and Gear Ratios

Possible Ratios:

12:36	1:3	66:200:600	200:600:1200
12:60	1:5	40:200:1000	120:600:3000
12:84	1:7	28:200:1400	84:600:4200
36:60	3:5	120:200:333	360:600:1000
36:84	3:7	85:200:466	255:600:1398
60:84	5:7	142:200:280	426:600:840

36:72	1:2	100:200:400	300:600:1200
48:84	4:7	114:200:350	342:600:1050

Offset:

36:72	1:2	100:200:400	300:600:1200
48:84	4:7	114:200:350	342:600:1050

Robot Parts and Chassis Design:
Kenny Wheel Parts

We made six wheels to use in our chassis. To make each we used the following parts:

Keps Nut
x4

Keps nuts include a built-in locking washer to protect against loosening from vibrations. In many cases, Keps nuts can also be tightened without the need for a wrench. Fully compatible with all VEX Robotics and VEX V5 hardware. Legal for use in the VEX Robotics Competition. **11/32" hex width** is compatible with all standard VEX tools.

¼ in. Spacer
x4

Spacers are used to create a space between two objects, often to properly position them. Available in various lengths.

60T High Strength Gears
x1

Build mechanisms capable of achieving higher torque or speed than ever before with **High Strength Gears** - lift heavier loads and survive bigger impacts with the additional gear ratio options provided by the largest high strength gear available.

1 ½ in. Screws
x4

There's nothing more frustrating than a screw with a stripped head. With VEX Star Drive Screws, this becomes a thing of the past. These star drive screws are able to withstand a greater amount of torque than standard hexagonal VEX screws, allowing builders to truly 'lock down' their mechanisms.

60 in. Omni Wheels
x4

Omni-Directional wheels roll forward like normal wheels, but slide sideways with almost no friction (no skidding during turns). Use these wheels to make your robot turn smoothly or build a holonomic drivetrain.

VEXpro Omni-Directional Wheels are manufactured from Glass-filled Nylon with high-traction rubber rollers. Compatible with VEXpro VersaHubs for driving with a sprocket or can be used with bearings for use on an axle.

Drive Shafts
x1

VEX Square Drive Shafts have rounded corners which allow them to easily spin in a round hole, while locking into a square hole. Insert these into a motor to power all of your applications.

- Use the 12" to make your own custom length shafts
- Works with motors, wheels, gears, and bearings

Source: [Home - VEX Robotics]

Name: Brenna Rosario
Date: 9/16/23
Project Name: Robot Parts and Chassis Design
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Robot Parts and Chassis Design:
Decision Matrix

Decision Matrix

Choosing the Best Design
A decision matrix is a tool to help you decide between multiple options by scoring them against different criteria. Using a decision matrix can help your team effectively and efficiently make tough decisions.

There are two ways to do this, a simple decision matrix and a weighted objective tool.
Decision Matrix

The steps to completing a Decision Matrix are:

1. Create a table and list all of the criteria along the top as the column headings.

2. List the design ideas along the left as the row headings.

3. Score each on a scale from 1 (poor) to 4 (very good). Yes or no question get a 2 (yes) or 1 (no).

4. Add up the row of scores when the table is complete and the row with the highest score is the winning design.

Weighted Objective Tool

A weighted objective tool weights the criteria so that some are worth more than others. In the example below, a scale of 1-10 was used which was then multiplied by the weight for that criteria. Make sure your teams decides on a scale and weighting before beginning to fill out the weighted objective tool.

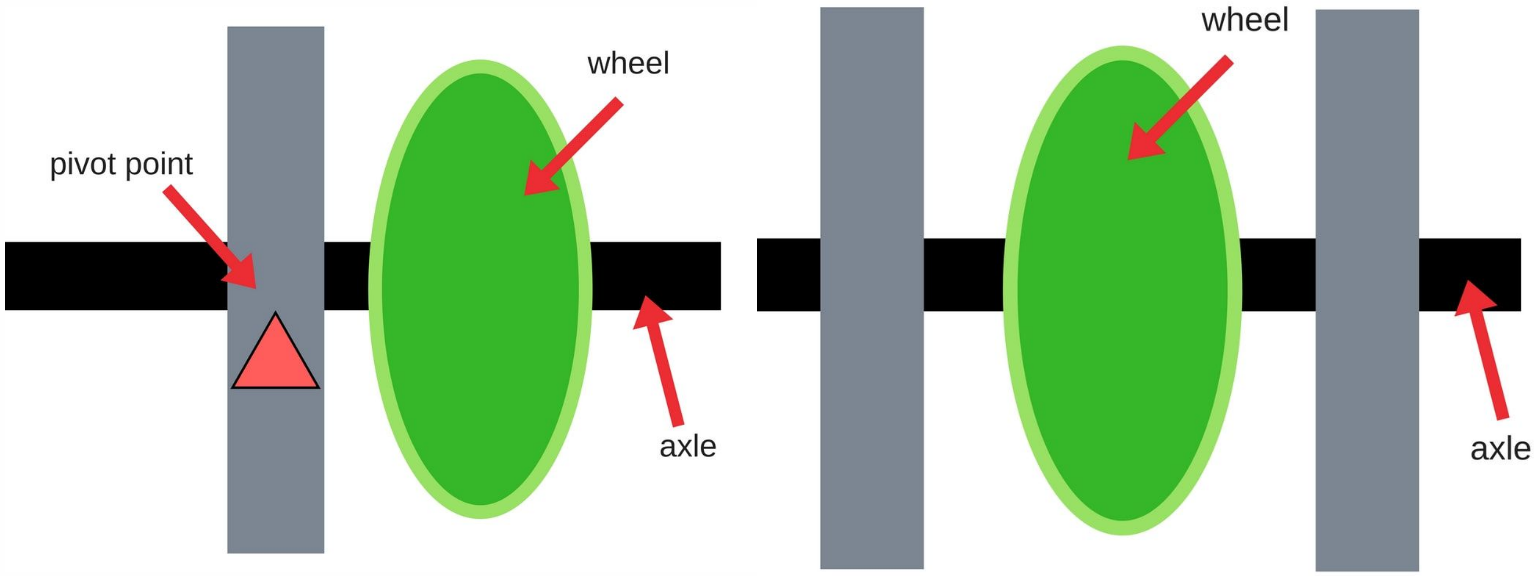
Since we are a more experienced team and already know which designs we like, we use the decision matrix. It helps us confirm our design choice, and guide us through smaller design choices. Overall, it is a very helpful tool when team members cannot decide on a design choice.

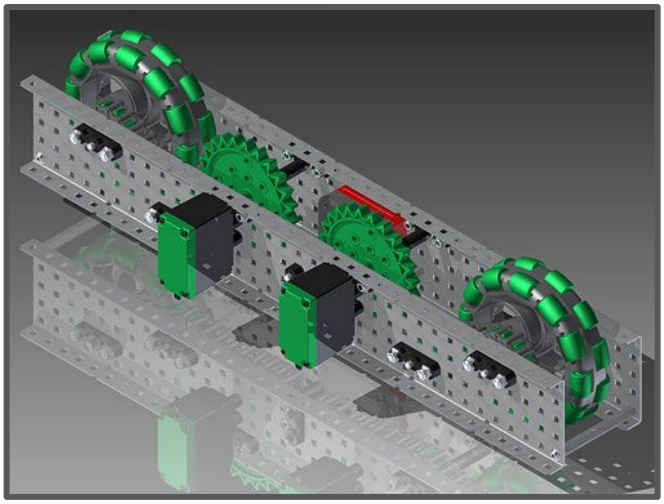
Source: https://cariwilliamzvex.weebly.com/choosing-the-best-idea.html

Robot Parts and Chassis Design:
Chassis Design Considerations

The Chassis is the base of the robot. The chassis design can affect how the robot drives, scores, and moves around the field. A chassis can have the added benefit of protecting important and fragile parts like the motors, wiring and cortex. It can also prevent the robot from tipping over.

When only one metal side is used, the drive shaft or axle sit on a pivot point like a teeter totter. This creates a loss of structural integrity and less precision when driving because the axle is not secure. Using two pieces of metal (as shown below with the grey rectangles) keeps the axle and wheel sturdy and secure. It is also important to use the bearing flats to reduce the friction when the axles turn in the metal square holes.



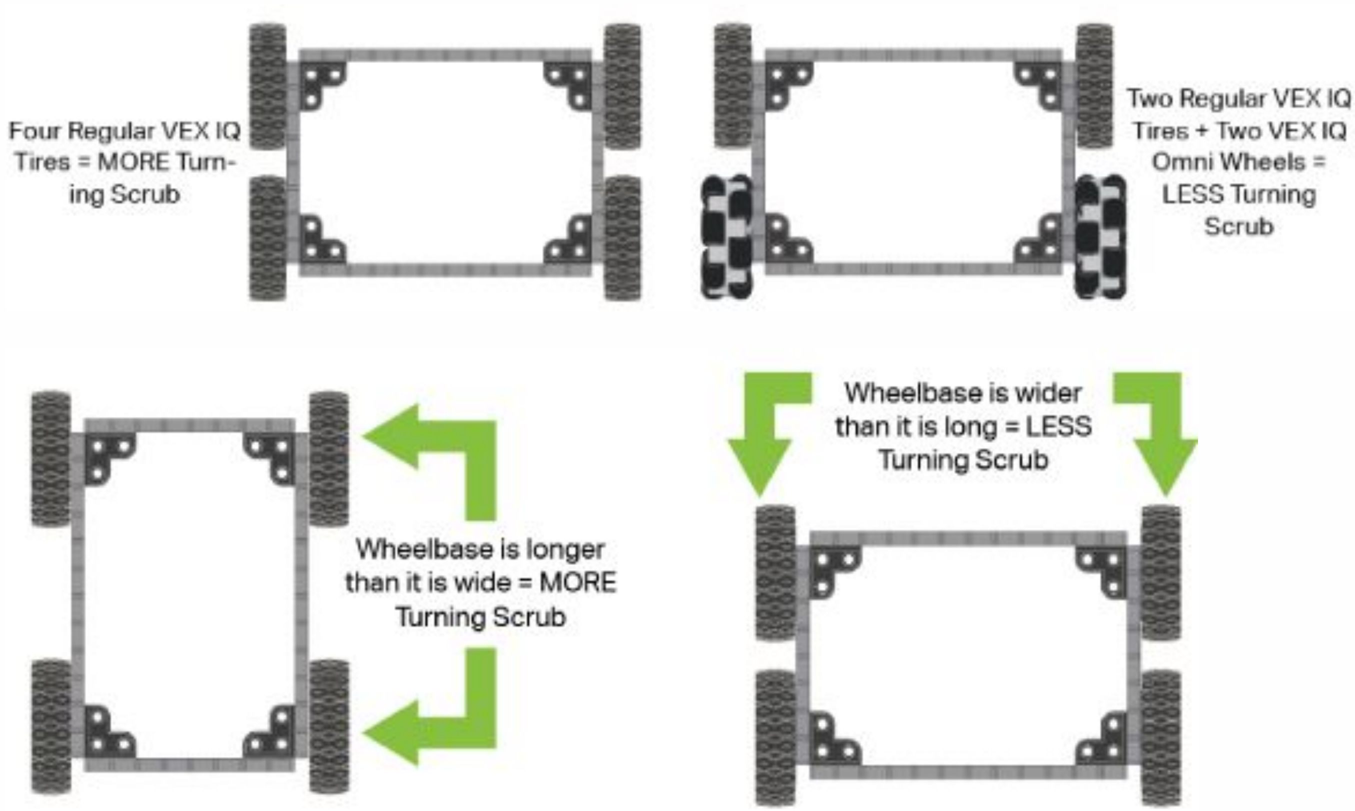


Source: https://cariwilliamzvex.weebly.com/robot-subsystem-1-chassis.html

Robot Parts and Chassis Design:
Chassis Design Considerations

Turning scrub is also something we will need to keep in mind. Turning scrub is the friction that resists turning. This friction is created from the wheels dragging sideways on the ground as a robot turns. Ideally, we want to reduce turning scrub in our design using Omni Directional wheels. However, there are some instances where friction may be beneficial.

The shape of the chassis also affects the turning scrub as shown below.



Source:
https://cariwilliamzvex.weebly.com/robot-subsystem-1-chassis.html

Robot Parts and Chassis Design:
Chassis Design Considerations

The square or rectangular shaped chassis is a sturdy structure that can handle a lot of stress from the mechanisms moving above. It also blocks the game pieces from entering the inside of the robot and getting stuck. In some instances, the metal frame acts as a plow to move objects around the field.

It is important to consider how the robot will need to interact with the game pieces. The four walls may get in the way of grabbers and intake systems. Make sure to design all three subsystems of the robot together before beginning to build the chassis.

Source: https://cariwilliamzvex.weebly.com/robot-subsystem-1-chassis.html

Robot Parts and Chassis Design: Chassis Design Considerations

The H-shaped chassis is another sturdy base and uses less metal than the square or rectangular shaped. It also allows areas for the others subsystems of the robot to operate in the front and back of the robot.

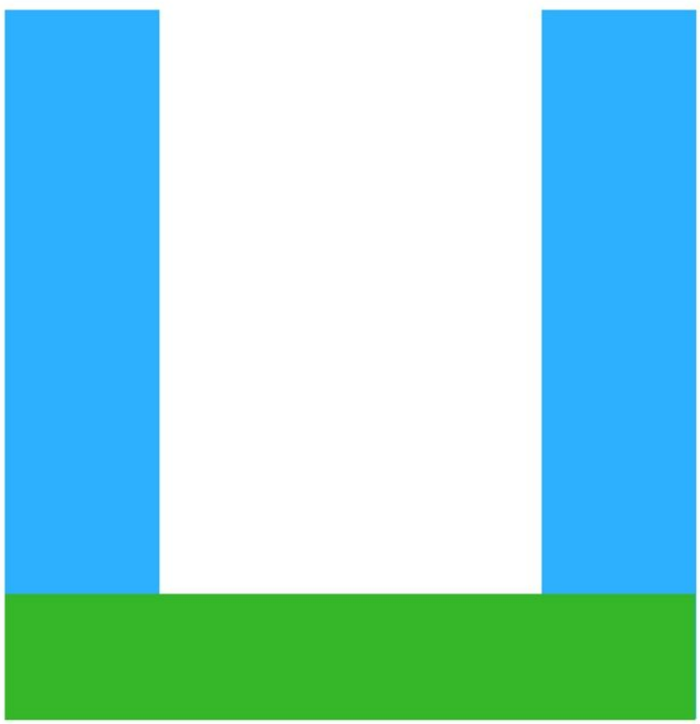
It is important to consider how the robot will need to interact with the game pieces. The central bar may get in the way of larger grabbers and intake systems so design all three subsystems of the robot together before beginning to build the chassis.

Source: https://cariwilliamzvex.weebly.com/robot-subsystem-1-chassis.html

Robot Parts and Chassis Design:
Chassis Design Considerations

The U-Shaped chassis loses a bit of structural integrity along the front of the robot. The central bar can be moved forward a bit and several screws can be used to help reinforce the back to help with maintaining the structural integrity.

However, the benefit is that there is ample room to operate a grabber or intake system inside of the robot.   Consider the game pieces as they may get trapped inside the U-shape when driving on the field.



Source: https://cariwilliamzvex.weebly.com/robot-subsystem-1-chassis.html

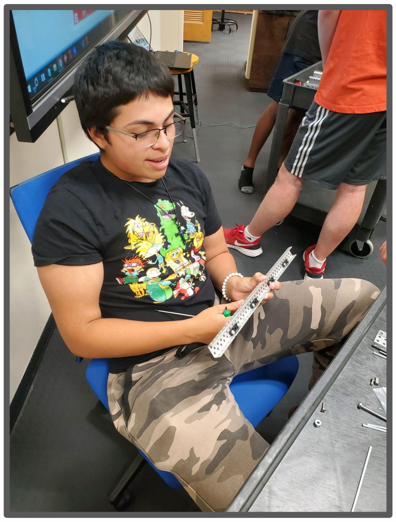
Robot Parts and Chassis Design:
Chassis Design Matrix

Decision Matrix

	Square/ Rectangular	H- Shaped	U- Shaped	Holonomic H/U Shaped
Maneuverability	5	4	3	5
Intake	5	3	4	5
Turning Scrub	5	3	4	4
Precision	5	5	4	3
Motor Spacing	5	4	3	5
Total	25	19	18	22

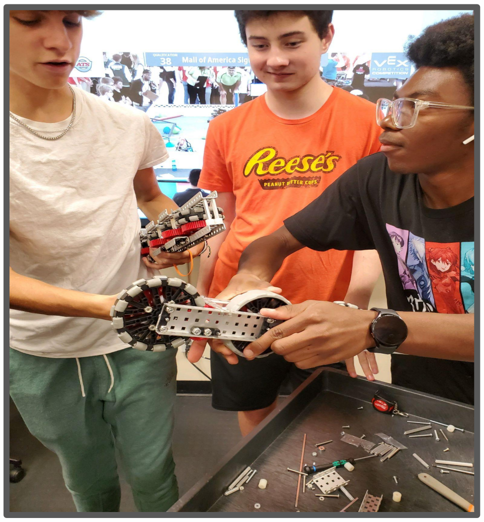
Decision:
Since the square/rectangular chassis design had the highest total amount of points, we chose to build ours in a rectangle shape. It was the easiest to move, particularly for our drivers style, and we had used a similar design in years before. We are still deciding on our intake design, but the rectangle allows for the most options. The design provides us with the preferred amount of friction, precision when driving, and motor placement.

Chassis Design



Today's Goals:

1. Decide on robot speed/ RPM
2. Begin chassis
3. Make Kenny wheels
4. Draw chassis diagram (when done)

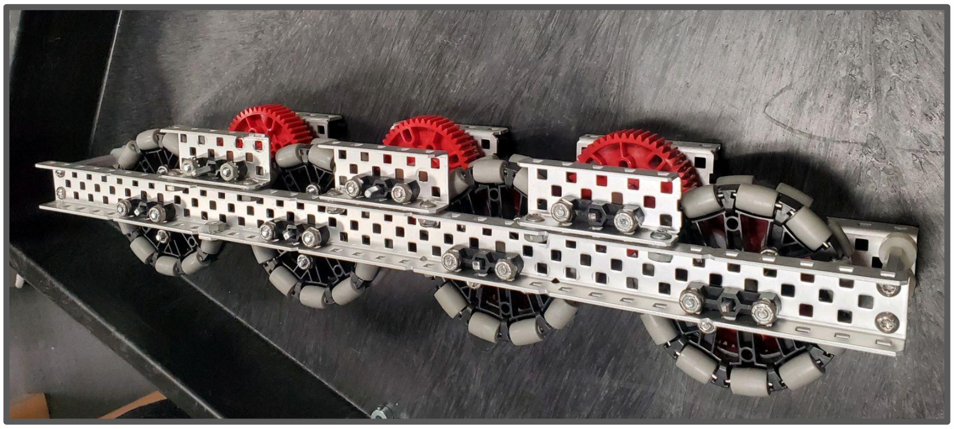


Who was here:

- Matt
- John
- Brenna
- Lazaro

Time and date: 9/17/23, 12pm-4pm

We revised our chassis design and began building our chassis using the design we created. We took into consideration the design ideas we decided on yesterday to create the best chassis design. We thought about field design, game pieces, and driver preferences to determine the best build. We began building, and by the end of the day had a chassis to being changing and expanding on.



Chassis Design:

Design Considerations

The chassis is the structural component for the robot which contains the drivetrain and allows the robot to be mobile by using wheels, tank treads, or another method. A chassis is sometimes referred to as the robot's frame. The chassis also provides a structure to attach manipulators such as arms, claws, lifts, plows, conveyor systems, object intakes, and other design features used to manipulate objects.

There are many considerations to be made when designing a robot chassis.

Purpose: What is the purpose of the robot? Is the robot design for a classroom project or is it for a competition? If the robot is for a classroom project its chassis may be assembled with less concern for repeated interactions with other robots. During a competition, if the chassis bends, twists, or falls apart the robot may no longer be able to compete effectively.

Size: Are there sizing rules for the robot? Many competitions have sizing rules included in the rules of the game. These rules could have a maximum height, width, and length the robot can have at the beginning of a match and the rules may have a maximum expansion horizontally and/or a maximum height limit. The chassis must be sized so all the robot's components will fit within the sizing rules.

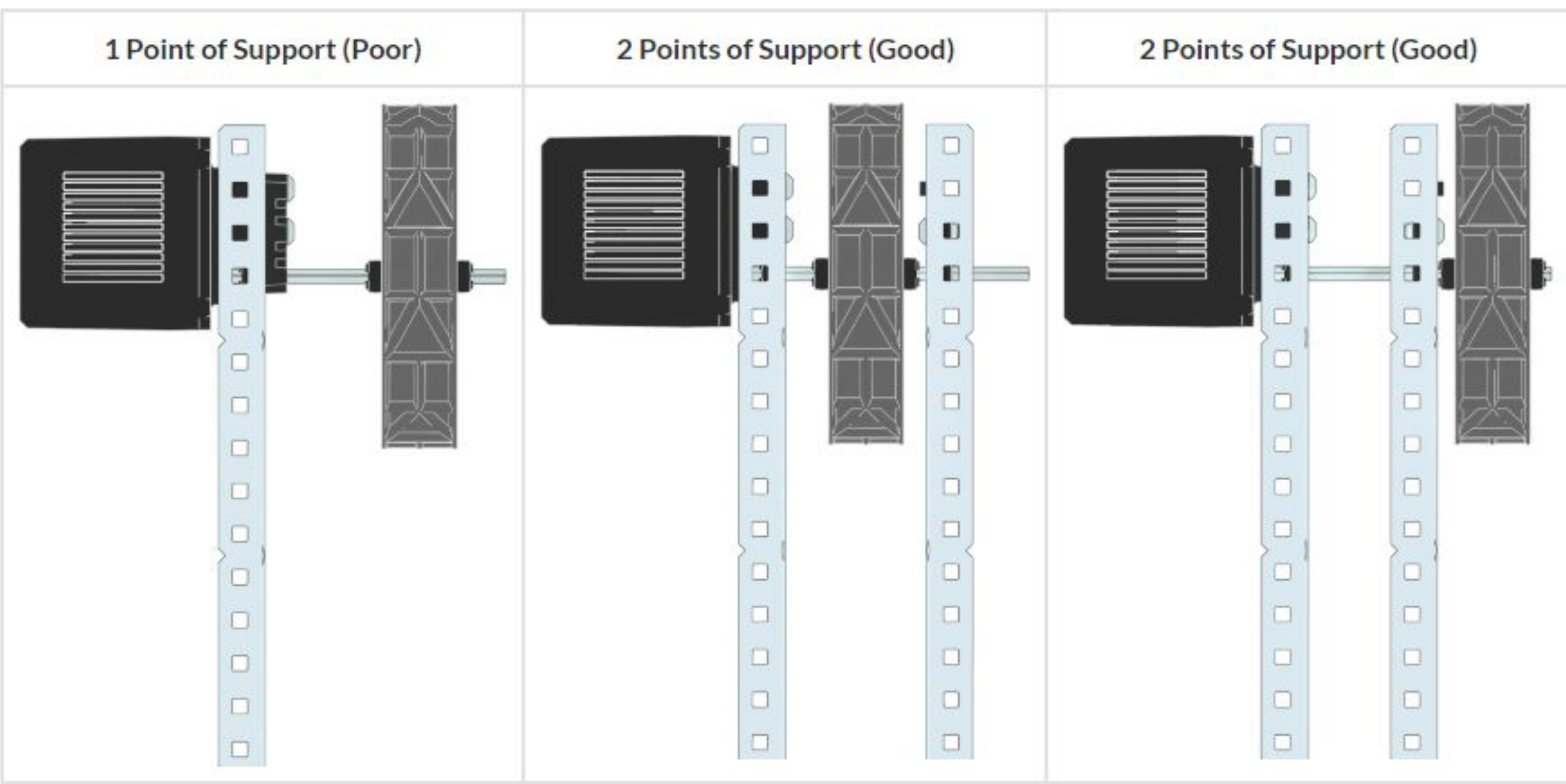
Shape: What shape will the chassis be? One of the advantages of the VEX EDR system is it allows for many designs and a nearly endless opportunity for creativity. However, there are some aspects to consider. The structural metal components assemble much easier when 90 o connections are used. The chassis shape should allow space for the robot's other components such as the control system, motors, wheels, gears, and sprockets. A good design practice is to lay out the chassis with all of the other components before the assembly to assure the spacing will work. Be sure the chassis shape will accommodate the robot's drivetrain design. If the robot will be used in a competition, are there shapes which will provide an advantage? Perhaps a narrower shape will allow the robot to navigate the field easier and/or fit into a scoring zone easier. Perhaps a wider shape will allow the robot to push more game pieces or provide more area for an intake system. Perhaps a U-shape will allow space for a conveyor and/or a game piece manipulator. Perhaps there is an obstacle the robot needs to go under and it can not be as tall. Perhaps the robot will need to reach high or outside the wheelbase and it will be advantageous to build the chassis shape to fill the maximum size limit and create as large and stable a footprint as possible.

Chassis Design:
Design Considerations

Support of Shafts

It is important that the design of the chassis incorporates two parallel points of support for any shafts which will be inserted into the chassis. If two supports are not provided for each shaft, the shaft will be allowed to slightly pivot up and down on the single point of support and it will make the shaft harder to spin. The heavier the robot assembly the shaft is supporting the more important it is to provide these two points of support.

Examples of two point support



Source: [Home - VEX Robotics]

Chassis Design:

Design Considerations

Structural Metal Pieces

What type of structural metal pieces will be used to assemble the chassis? The VEX EDR system has many available options in steel and aluminum. There are C-Channels available in 5 Hole and 2 Hole width in both steel and aluminum. There are aluminum C-Channels in 3 Hole width available. The wider the C-Channel, the less likely it is to bend or twist, however the chassis will be heavier. There are Angles available in both steel and aluminum with square holes and there are steel Angles with slotted holes. Angles are ideal for attaching and supporting towers. The steel Angle with slotted holes allows for connections which are not 90 o. There are Rails available in both steel and aluminum. Rails have end connectors which provide an additional connection point. Rails are one of the types of structural metal included in the Chassis Kits.

C-Channel	Angle	Rail
		

Source: [Home - VEX Robotics]

Chassis Design:

Design Considerations

Things to consider when selecting a structural metal material. VEX offers metal structure pieces in two material options: steel and aluminum. There are advantages and disadvantages to using a specific material based on the material properties and the pieces available. Both material options can be cut, drilled, filed, and re-shaped to allow for custom designs.

The steel structural metal was the original material which was available when the VEX EDR system was introduced. When trying to decide whether to use a steel structural piece, here are a few things which should be considered in the decision:

- Steel metal pieces are less expensive than aluminum and this may be a consideration in classroom projects.
- Steel metal pieces do not bend or twist as easily as the same metal pieces made out of aluminum.
- Steel metal pieces are available in the Boaster Kit and the Metal Hardware Kit.
- Steel metal is available in 4 different sized Chassis Kits which can be mixed and matched for a number of different designs.
- Steel metal is also available in a number of single type/length metal component packs.

The aluminum structural metal was introduced later in the VEX EDR product line, however its properties make it widely used for designs in robotic competitions. When trying to decide whether to use an aluminum structural piece, here are a few things which should be considered in the decision:

- Aluminum metal pieces are lighter and this provides a competitive advantage because the lighter the structure, the easier it is for motors and pneumatic systems to move it.
- Aluminum pieces are slightly thicker than the steel pieces and in certain orientations, it is more difficult to align the holes between 2 or more pieces.
- Aluminum pieces are softer than the steel pieces which can allow screws and drive shafts to dig into the sides of the square holes when they have a large stress placed on them and this can create a loose connection. However this softness allows aluminum to be cut, drilled, filed, and re-shaped easier than steel.
- Aluminum Metal pieces are available in the Aluminum Structure Kit and the Long Aluminum Structure Kit.
- Aluminum is available in an Aluminum Chassis Kit 25x25.
- Aluminum metal is also available in a number of single type/length metal component packs.

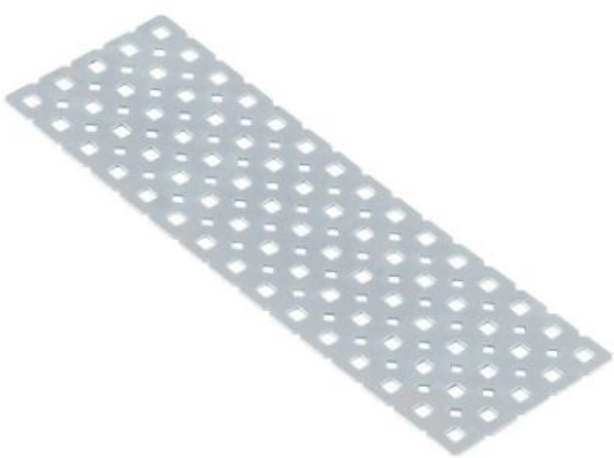
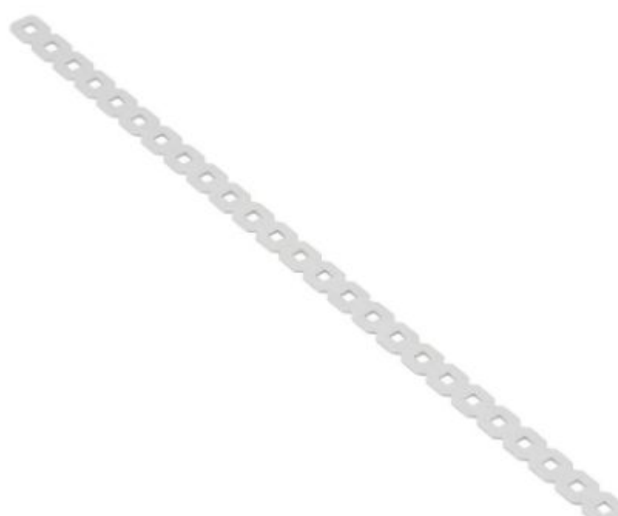
Chassis Design:

Design Considerations

All of these metal pieces can be mixed and matched to assemble a very effective robot chassis. The decision about which type of metal to use does not have to be an all or none. For example, aluminum angle and rails might be used for the drivetrain part of the chassis in order to keep it light and steel C-Channel might be used for the tower part of the chassis in order to provide strength to support a large arm or lift system.

It needs to be noted that metal Plates and metal Bars (which are also available in both steel and aluminum) were left out of this discussion of Structural Metal pieces. This is because plates and bars do not have material which extends in all 3 (X,Y,&Z) spatial axis and therefore do not have the structural strength to be used as a main component for a chassis. However, these metal parts can serve some very important functions in a chassis such as:

- Plates and Bars can be used to support and connect the other structural components to stiffen a chassis.
- Steel Plates or steel Bars can be mounted flush to a piece of aluminum structural metal to reinforce its square holes when a shaft or screw is inserted through the hole and the shaft/screw has a large stress applied to it.
- Plates and Bars can provide a flat surface on a chassis to mount components like the V5 Robot Brain, the V5 Robot Radio, and the V5 Robot Battery.

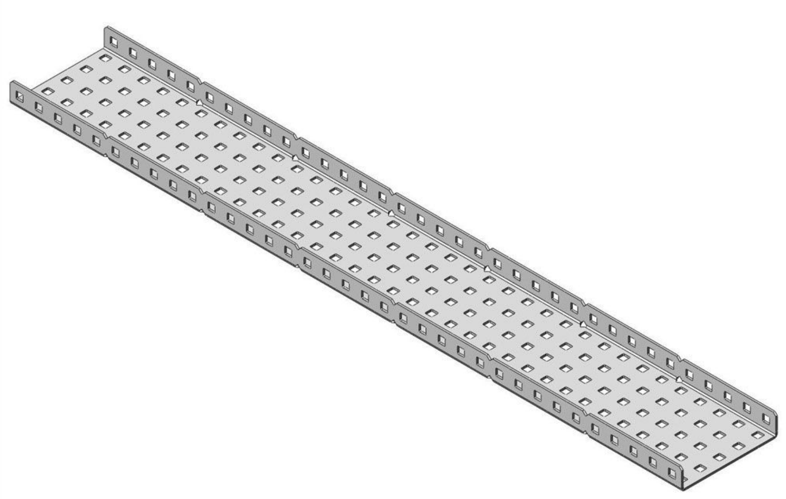
Plate	Bar
	

Source: Home - VEX Robotics

Chassis Design:
Design Considerations

Fasteners

How are fasteners used to assemble the chassis? Fasteners are parts which connect the metal pieces and other structures together. There are numerous fasteners available to assemble a chassis. Unless the chassis has a structure which is designed to pivot, each junction needs to have two or more connection points. As a general rule, the more stress a junction has the more fasteners should be used, however this will equal more weight for the design. For example, if two 5 hole C-Channels are being connected, placing a screw through all 25 intersecting holes would be excessive. A competition chassis needs to be assembled with screws and nuts. 1-Post Nut Retainers and/or 4-Post Nut Retainers may also be used. Standoffs are also very effective for assembling a chassis. A standoff is used to separate two parts from one another while creating a rigid connection. The #8-32 Standoffs come in various lengths between ¼" and 6". In addition to these fasteners, the VEX Robotics Competition has a game rule about "Non-VEX screws" which allows any commercially available #4, #6, #8, M3, M3.5, or M4 screw up to 2" (50.8mm) long (nominal), and any commercially available nut, washer, and/or spacer (up to 2" / 50.8mm long) to fit these screws. Chassis junctions may also be reinforced using Gussets, Plates and/or Bars.



Source: Home - VEX Robotics

Chassis Design

Our team has adopted the "Kenny Wheel" design for our robot chassis, and it has remained a consistent choice since the Change Up season in 2020-2021. This design was originally developed for our robot, named Kenny, and we've continued to use it because of its proven effectiveness.

The key innovation behind the Kenny Wheel design involves the method of attaching gears to omni wheels. Instead of placing them on the same shaft, we opt for a unique approach by sandwiching gears onto the omni wheels. This distinctive design choice is driven by its ability to eliminate slack and enhance the overall performance of our robot. By mitigating slack, we ensure that our robot can maintain precision and control during its movements, a crucial factor in navigating the dynamic and challenging game environments.
Our initial concept began with using 6 4-inch wheels for our robot's drivetrain. However, our design change when we took inspiration from Team “Ace”. This caused a significant pivot in our design strategy. We decided to opt for a more agile and speed-focused approach by incorporating 3.25-inch wheels, coupled with a gear configuration that included a 60-teeth gear driving a 48-teeth gear, operating at a brisk 480 revolutions per minute (rpm).

The pivotal factor guiding our decision to embrace this setup is importance of speed, especially for our driver. A swifter robot not only provides a competitive edge but also allows for more dynamic and agile maneuverability on the field. By changing our design in this manner, we aim to maximize the robot's velocity and responsiveness, ensuring that it aligns seamlessly with our driver's preferences and, ultimately, enhancing our prospects in the competition.

Chassis Design:

Parts

Keps nuts include a built-in locking washer to protect against loosening from vibrations. In many cases, Keps nuts can also be tightened without the need for a wrench. Fully compatible with all VEX Robotics and VEX V5 hardware. Legal for use in the VEX Robotics Competition. **11/32" hex width** is compatible with all standard VEX tools.

Keps Nut
x4

There's nothing more frustrating than a screw with a stripped head. With VEX Star Drive Screws, this becomes a thing of the past. These star drive screws are able to withstand a greater amount of torque than standard hexagonal VEX screws, allowing builders to truly 'lock down' their mechanisms.

1 ½ in. Screws
x4

Spacers are used to create a space between two objects, often to properly position them. Available in various lengths.

¼ in. Spacer
x4

VEX Square Drive Shafts have rounded corners which allow them to easily spin in a round hole, while locking into a square hole. Insert these into a motor to power all of your applications.

- Use the 12" to make your own custom length shafts
- Works with motors, wheels, gears, and bearings

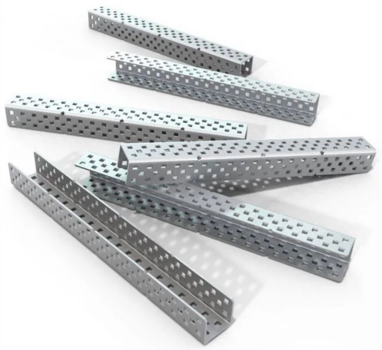
Drive Shafts
x1

Build mechanisms capable of achieving higher torque or speed than ever before with **High Strength Gears** - lift heavier loads and survive bigger impacts with the additional gear ratio options provided by the largest high strength gear available.

60T High Strength Gears
x1

Chassis Design:

Parts



C Channel
x3

VEX C-Channel has holes on 0.500" increments. This structural member's excellent strength and bending resistance is perfect for building robust robots.

- Multiple sizes available, in two different material types
- Made from cold rolled steel, or 5052-H32 Aluminum
- Each channel is segmented into cuttable 2.5" pieces

The **High Strength Shaft Bearing** is a larger version of the Bearing Flat that is designed for the 0.25" High Strength Shafts.

VEX V5 2", 3", and 4" High Strength Shafts are actually designed about 1mm shorter than their respective 2", 3", and 4" #8-32 Standoffs.

This means that if you use standoffs to hold together two pieces of metal, the High Strength Shaft can rest on High Strength Shaft Bearings attached to those two pieces without any cutting required.

- Mounts directly onto VEX V5 structure
- Low friction allows shafts to turn smoothly
- Mount with Screws & Nuts or Attachment Rivets

High Strength
Bearings
x14

60 in. Omni
Wheels
x4

Omni-Directional wheels roll forward like normal wheels, but slide sideways with almost no friction (no skidding during turns). Use these wheels to make your robot turn smoothly or build a holonomic drivetrain.

VEXpro Omni-Directional Wheels are manufactured from Glass-filled Nylon with high-traction rubber rollers. Compatible with VEXpro VersaHubs for driving with a sprocket or can be used with bearings for use on an axle.

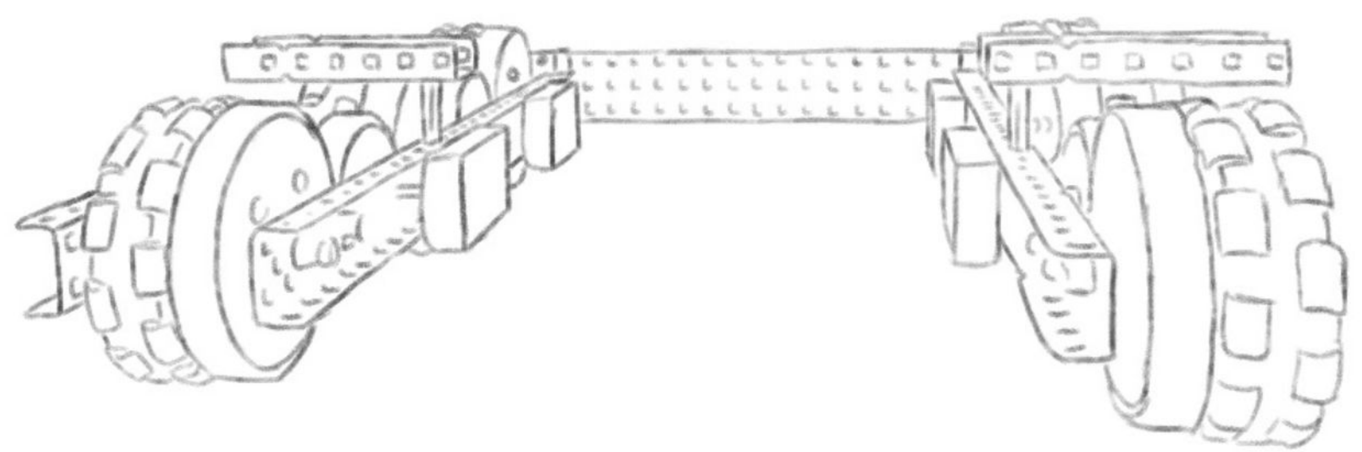
Source: Home - VEX Robotics

Chassis Design

In our design, we strategically incorporated a combination of six 3.5-inch omni wheels and two 2.2-inch omni wheels at the front of our 8x8 base. This choice was driven by the inherent compactness of the base, which presented a unique challenge. By positioning the extra wheels at the front of the base, we aimed to create a dynamic and innovative solution that functions much like a sled, allowing our robot to effortlessly overcome obstacles such as the central bar.

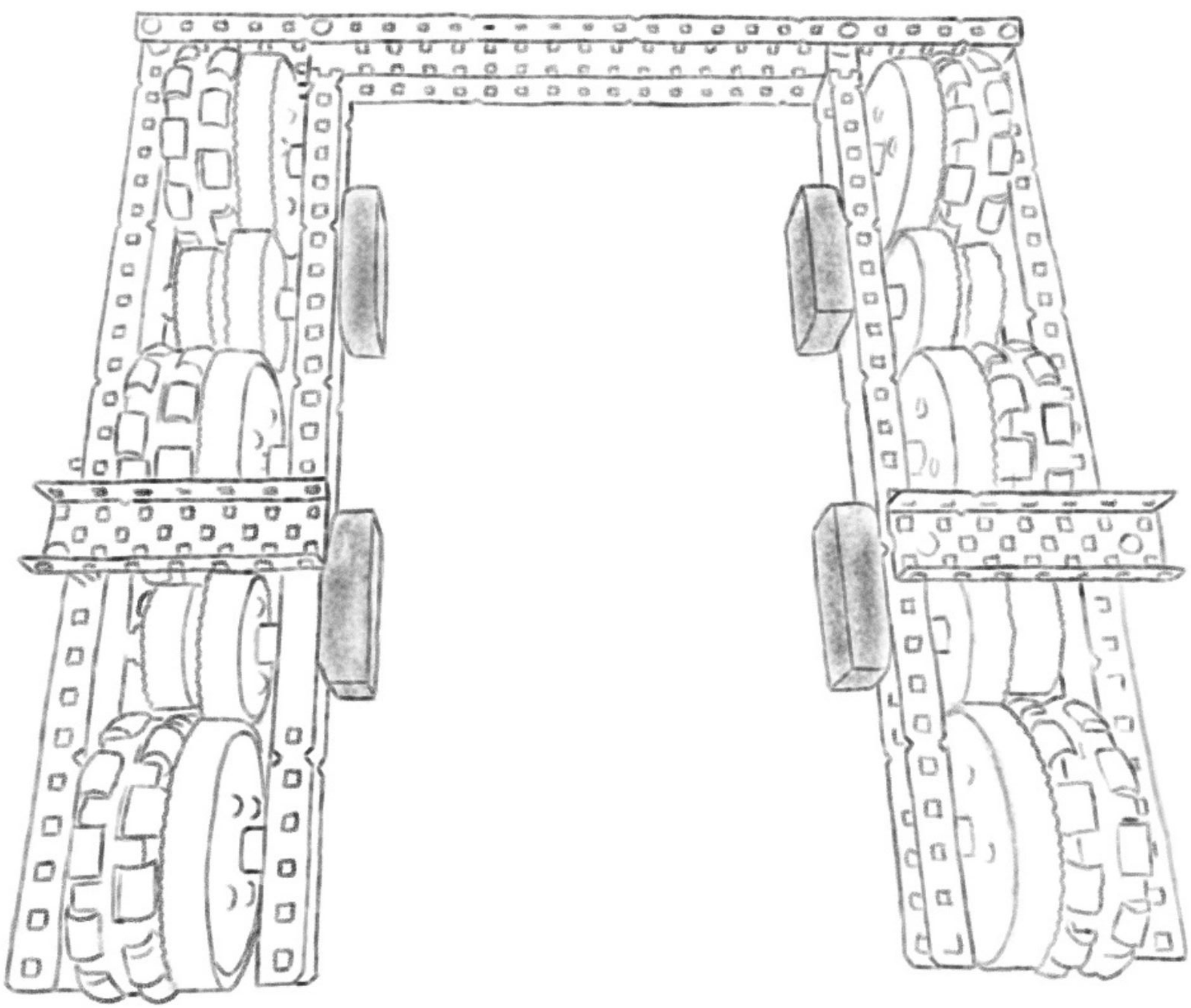
This configuration not only enhances the overall maneuverability of the robot but also allows it to surmount challenges- such as the center bar- with remarkable ease. The larger 3.5-inch omni wheels provide stability and better weight distribution, ensuring that our robot maintains balance even when traversing uneven surfaces. Meanwhile, the smaller 2.2-inch omni wheels at the front act as a pivotal component of our design, enabling the robot to efficiently navigate over the central bar.

Through this thoughtful combination of omni wheels, we have created a versatile and capable robot chassis that can conquer a wide range of obstacles, making it an ideal choice for various applications that demand both agility and adaptability.

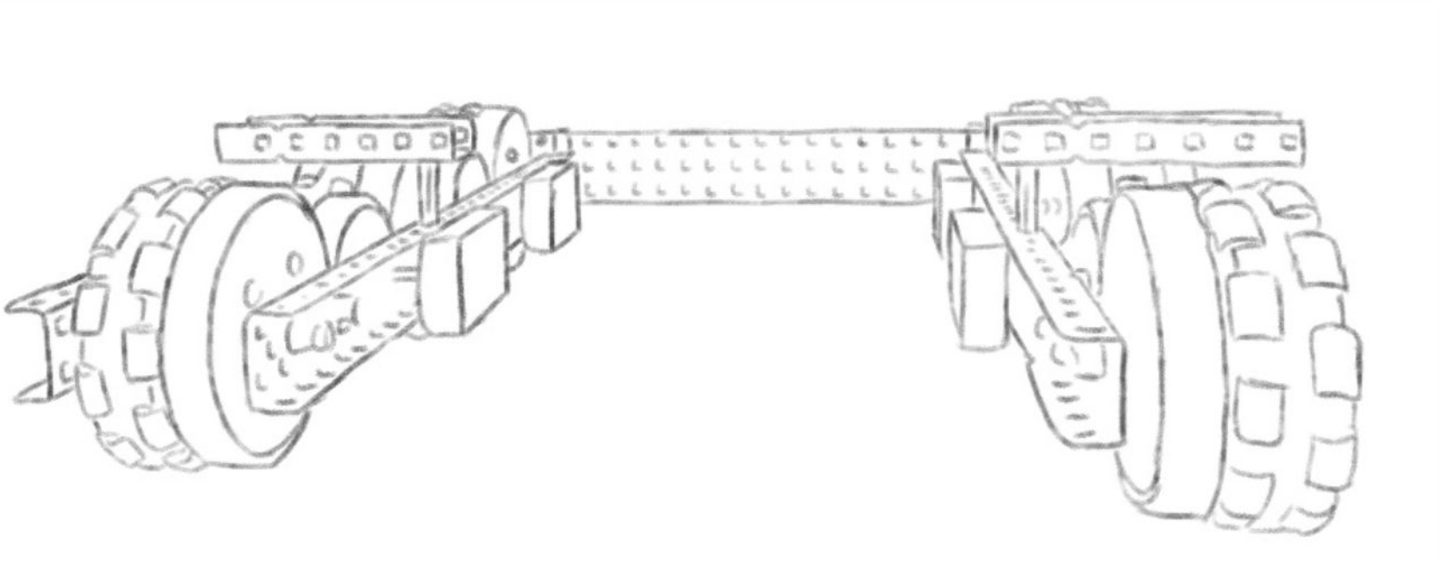


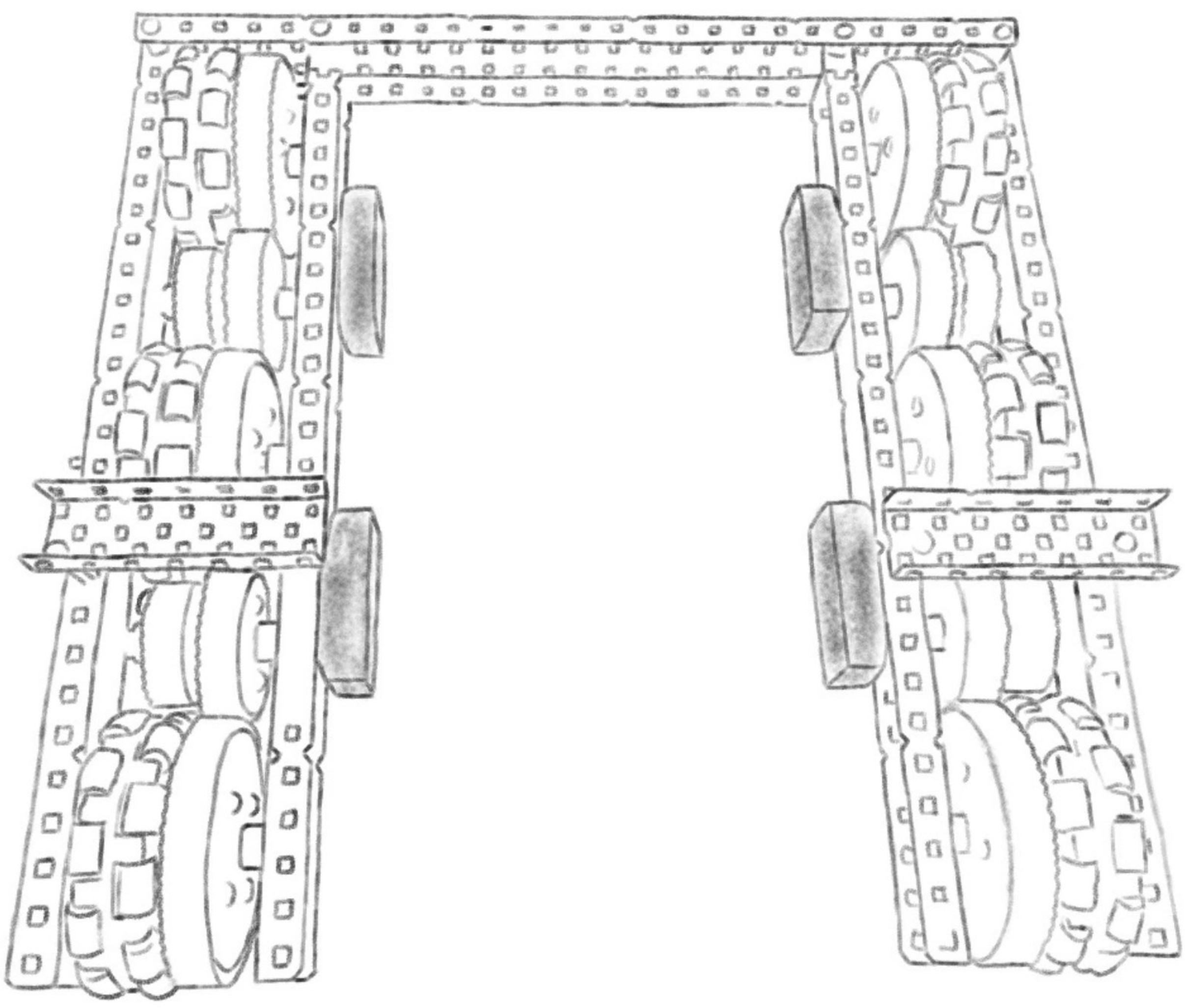
Chassis Design

Based off of what we found as the best option in our design matrix, we chose to build a rectangle/square wheel base. We decided to make it 8x8, as that is a size we have worked with in the past.



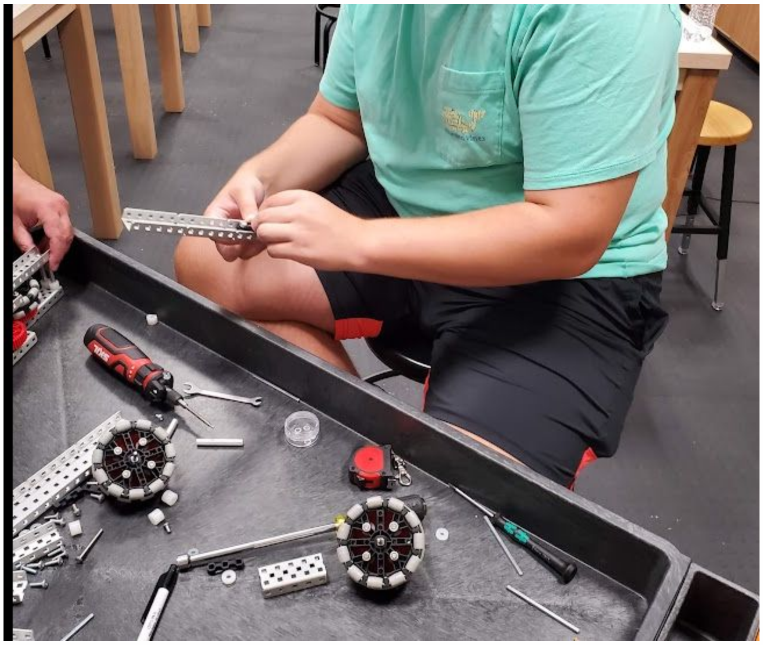
Chassis Design: Final Sketches





Chassis Design: Beginning Build

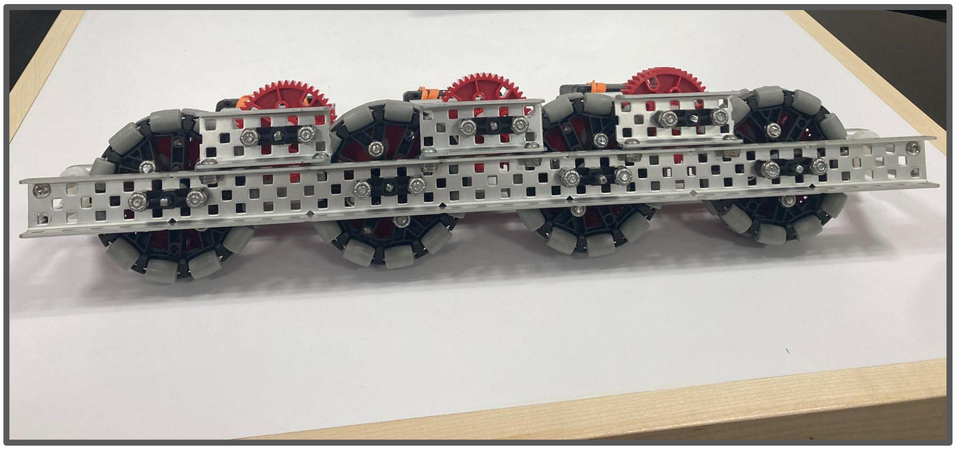
In the initial phase of our construction, we strategically used a pair of c-channels, to encapsulate three of our specialized "Kenny wheels". We incorporated half-inch spacers between each wheel-c channel, mitigating any potential extraneous friction. Taking design considerations into account, we seamlessly integrated two high-strength gears, varying in size, between the Kenny wheels. Each gear was meticulously separated by half-inch spacers, contributing to the overall operational efficiency of our system. The latter section of the chassis was systematically built, adhering to the pattern: Kenny wheel, gears, Kenny wheel, gears, Kenny wheel – a sequence optimized for enhanced performance. This design was mirrored, doubling the first half of the chassis. To bring together the halves, we attached a channel at the rear, which helped with structural integrity. With a strong foundation, we horizontally fixed two smaller sections of c channels atop the second set of gears. This not only served as a structural framework but also laid the groundwork for subsequent components, enhancing the overall structural integrity and functionality of our robotic system.



Chassis Redesign

Today's Goals:

1. Finish mirroring chassis
2. Discuss wheel types
3. Discuss gears



Who was here:

- Matt
- John
- Lazaro

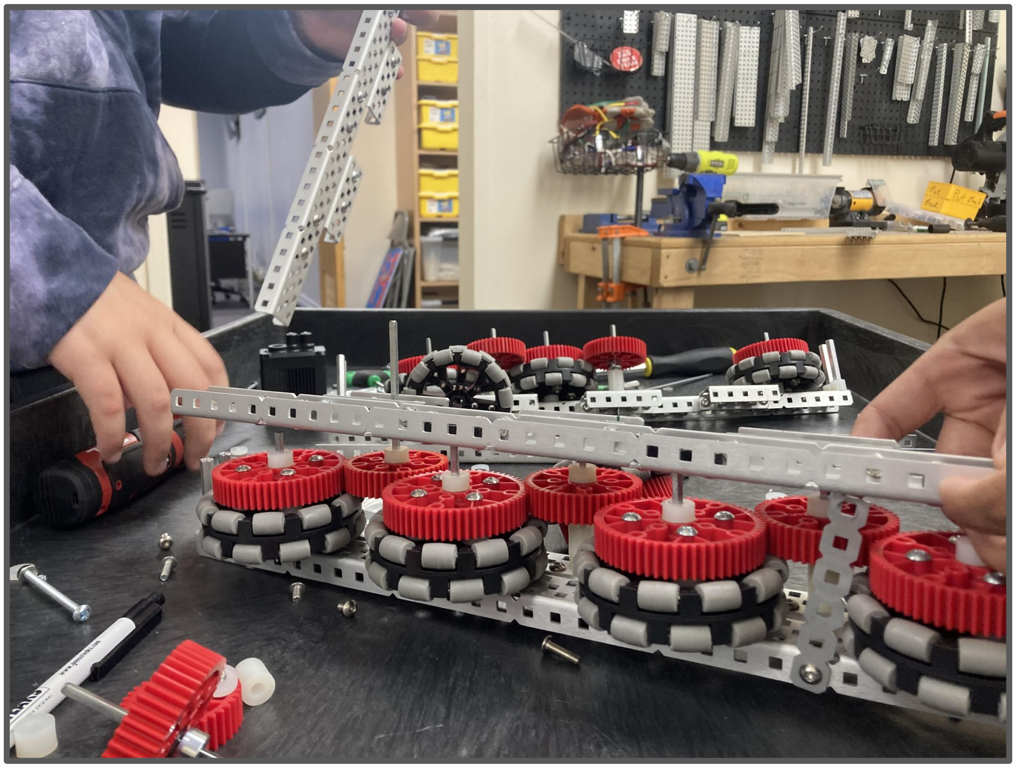
Time and date: 9/23/23, 10am-4pm

We began by finishing our chassis. We had completed it last weekend, but wanted to make a few changes. We made the changes on one side and mirrored them on the other. When we tested the robot we experienced some inconsistencies with drifting, and tried to find ways to solve the problem. To do so, we made a decision matrix of each of the wheel types, and determines which would be best. We then redesigned and rebuilt the chassis.

Chassis Redesign

We have made significant progress in the past two meetings. Initially, we had just half of the chassis completed, but today marked a crucial step as we successfully built the other side to mirror our existing work.

We then equipped our robot with motors, a vital component that brought the mechanical elements to life, and connected the brain to the robot's electronic systems. This allowed us to finally take our robot for a test drive. However, during the test drive, we encountered some unexpected challenges. The eight omni wheels we initially used resulted in inconsistent drifting as we navigated the robot, prompting us to reconsider our chassis design.



Name: Brenna Rosario
Date: 9/23/23
Project Name: Chassis Redesign
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

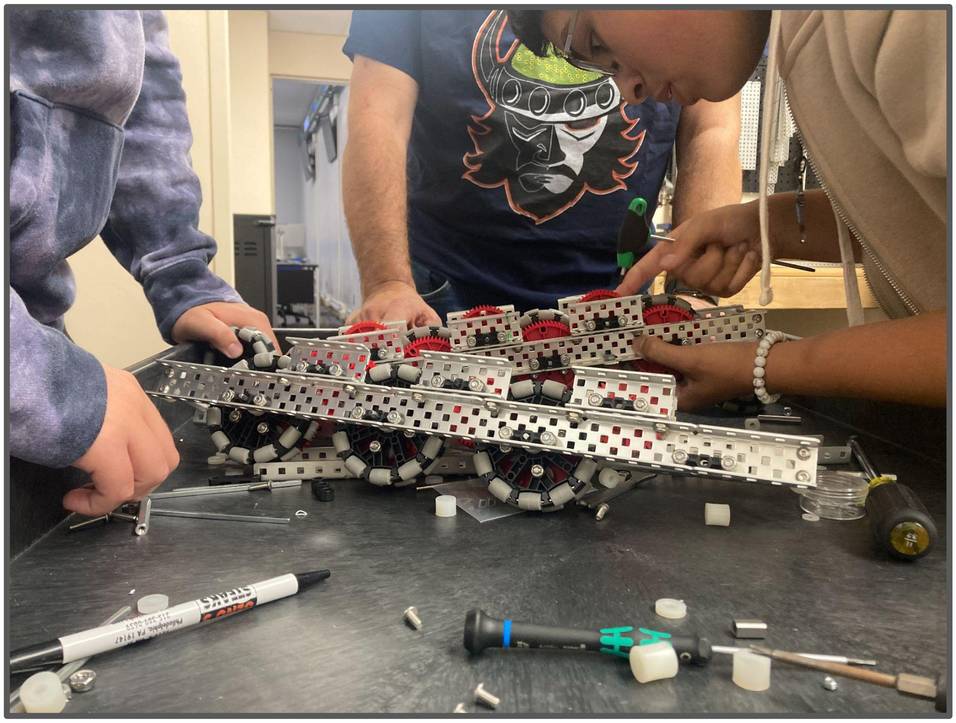
Chassis Redesign

In response to these challenges, we took to online forums to seek inspiration and alternative solutions. Here, we stumbled upon a CAD representation of a robot that closely aligned with our original design ideas, as captured in the decision matrix highlighting options for the number of wheels. One concern had been the proximity of the 72-tooth gears to the 3.25-inch omni wheels, as we worried they might touch the floor. However, our perception changed after seeing the design on the forums, as we realized that the gears touching the floor was not a problem. The slight difference in size between the gears and wheels was caused as the robot's weight naturally sank it into the tiles, exposing the gears to the floor. Importantly, the gears' contact with the floor posed no impediment to functionality, as they directly influenced the rotation of the wheels in the same direction, eliminating friction-related issues.

Problem: Gears and wheels were touching the floor.

Ideas: Change wheels used in drive train.

1. H Drive Omni
2. H Drive Mecanum
3. Holonomic Drive/ X Drive



Chassis Redesign

Decision Matrix

	H Drive Omni	H Drive Mecanum	Holonomic Drive/ X Drive
Reliability (1-5)	5	4	3
Driving Direction (1-5)	4	4	5
Compactness (1-5)	5	4	3
Weight (1-5)	1	2	3
Speed (1-5)	5	4	2
Total	20	18	16

Solution: Based off the pros and cons of each drive train style that we listed as well as our knowledge of each of the wheels and chassis designs, we created a decision matrix to help us decide which drivetrain to use. We included factors like reliability, weight, speed and more. We tried each drive train out and based off how each one performed we scored them accordingly. The drive train that had the most points was holonomic drive with omni wheels. Since we were already using omni wheels, we weren't sure what to do to fix our robot. However, since it was close to the end of the meeting, we decided to work on the journal and go over the different wheel types, saving the robot's issue for tomorrow's meeting.

Chassis Redesign:
Wheel Types- Omni Directional Wheel

Mounting Hardware Guide

- Mounting (1) Keyed or Hex VersaHub - 1/4" or 3/8" long screw
- Mounting (1) Plate Sprocket and (1) Sprocket VersaHub - 1" or 1.25" long screw
- Mounting (2) Plate Sprockets and (2) Sprocket Versahubs - 1.5" or 1.75" long screw

These Omni-Directional wheels were designed from the ground up to give the smoothest ride possible. VEX's construction method uses a dual roller design that allows for a constant contact patch with a narrow profile. Each roller is tailored for the individual wheel diameter, and provides the correct, constant radius. We don't share rollers between wheel types -- these wheels aren't "almost round" they're actually round. This smooth-ride provides higher efficiency and reduces wasted power!

Omni-Directional wheel assembly hardware is separate from sprocket mounting hardware. Sprockets are screwed into captive 8-32 standoffs. This allows for easy removal and replacement of sprockets without disassembling the entire wheel. No more worrying about your whole wheel falling apart just because we wanted to remove the sprocket.

Source: Home - VEX Robotics

Chassis Redesign:
Wheel Types- Traction Wheels

Mounting Hardware Guide

- Mounting (1) Keyed or Hex VersaHub - 1/4" or 3/8" long screw
- Mounting (1) Plate Sprocket and (1) Sprocket VersaHub - 1" or 1.25" long screw
- Mounting (2) Plate Sprockets and (2) Sprocket Versahubs - 1.5" or 1.75" long screw

VEXpro Traction Wheels are designed to be the ultimate in versatility and performance. These wheels include the VEXpro VersaKey mounting system, which ensures every sprocket, hub, and gear are perfectly piloted -- no more wobbly sprockets!

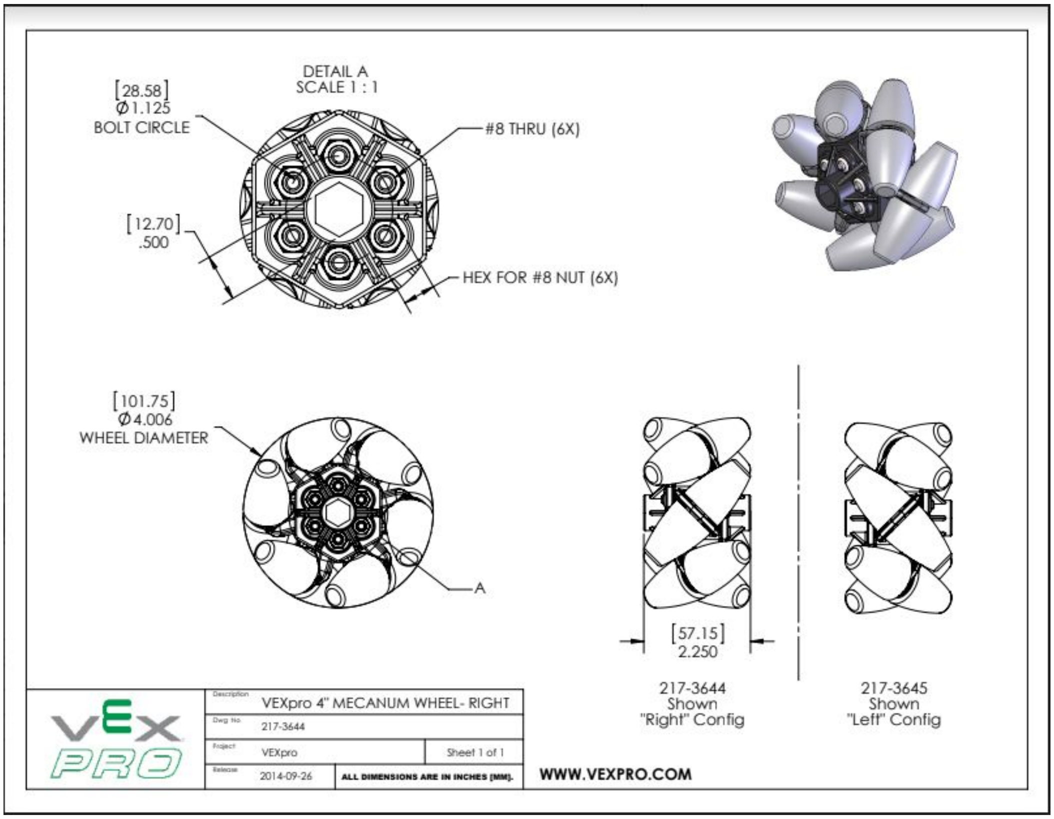
Wheels are manufactured from Glass-filled Nylon. Each Traction Wheel comes assembled in 1” wide configuration and also includes all hardware for 1.5” and 2” wide configurations.

Traction wheel assembly hardware is separate from sprocket mounting hardware. Sprockets are screwed into captive 8-32 standoffs. This allows for easy removal and replacement of sprockets without disassembling the entire wheel. No more worrying about your whole wheel falling apart just because you wanted to remove the sprocket.

Each traction wheel includes holes for use as bearing retainers.

Source: [Home - VEX Robotics]

Chassis Redesign:
Wheel Types- Mecanum Wheels



Mecanum wheel assembly hardware is separate from sprocket mounting hardware. Sprockets are screwed into captive 8-32 standoffs. This allows for easy removal and replacement of sprockets without disassembling the entire wheel. No more worrying about your whole wheel falling apart just because you wanted to remove the sprocket

These mecanum wheels were designed from the ground up to give the smoothest ride possible. Each roller is tailored for the individual wheel diameter, and provides the correct, constant radius. We don't share rollers between wheel types -- these wheels aren't "almost round" -- they're actually round. This smooth-ride provides higher efficiency and reduces wasted power. This is especially important in mecanum drivetrains to provide smooth holonomic motion without high motor current draw.

VEXpro Mecanum Wheels are manufactured from Glass-filled Nylon, with ABS-PC roller mounts and rubber rollers.

Source: Home - VEX Robotics

Name: Brenna Rosario
Date: 9/23/23
Project Name: Chassis Redesign
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Chassis Redesign Part 2

Today's Goals:

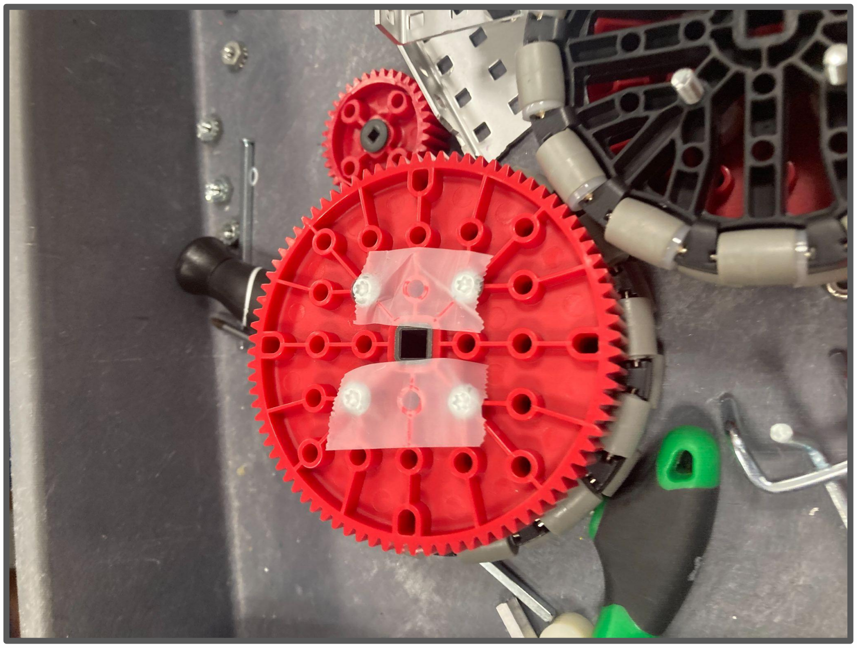
1. Discuss gear ratios (speed and torque)

Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 9/24/23, 12pm-4pm

We began by discussing the relationship between speed and torque in our robot. We used what we learned to make a more informed decisions about the gear ratio of our robot.



Chassis Redesign Part 2

In response to the challenges encountered during our initial test drive, we made the decision to disassemble and rebuild the chassis from the ground up. This time around, we opted for a revised and more robust configuration, featuring six motors and a 6-wheel drive system. The choice of 3.25-inch omni wheels, combined with a gear ratio of 72 teeth to 48 teeth, results in an impressive 400 revolutions per minute (RPM).

The emphasis on achieving a higher RPM was deliberate due to the importance of speed. This attribute holds significant value not only for our skilled driver but is also crucial for conquering this year's game challenge. By selecting this setup, we aim to maximize our robot's velocity and agility, aligning its performance characteristics with the unique demands of the game. We discussed gear ratios more in the following pages.

A **Gear Ratio** change is one of the easiest ways to change Mechanical Advantage in a mechanism or system to achieve desired speed and/or torque. Using different sized gears meshed together in a gear train can change the speed or torque provided by the motor.

The speed/torque relationship are inverse to one another, meaning they are opposite. When you increase speed, you decrease torque. When you increase torque, you decrease speed. Torque can be thought of as the amount of power provided as a twisting force on the drive shaft.

Gear ratios can be mathematically calculated by counting the number of teeth on the gear.

Gear Formulas

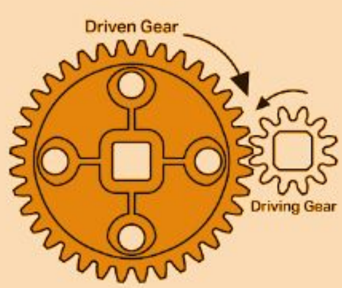
$$\text{Gear Ratio} = \frac{\text{\# of Driven Gear Teeth (Output)}}{\text{\# of Driving Gear Teeth (Input)}}$$

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.

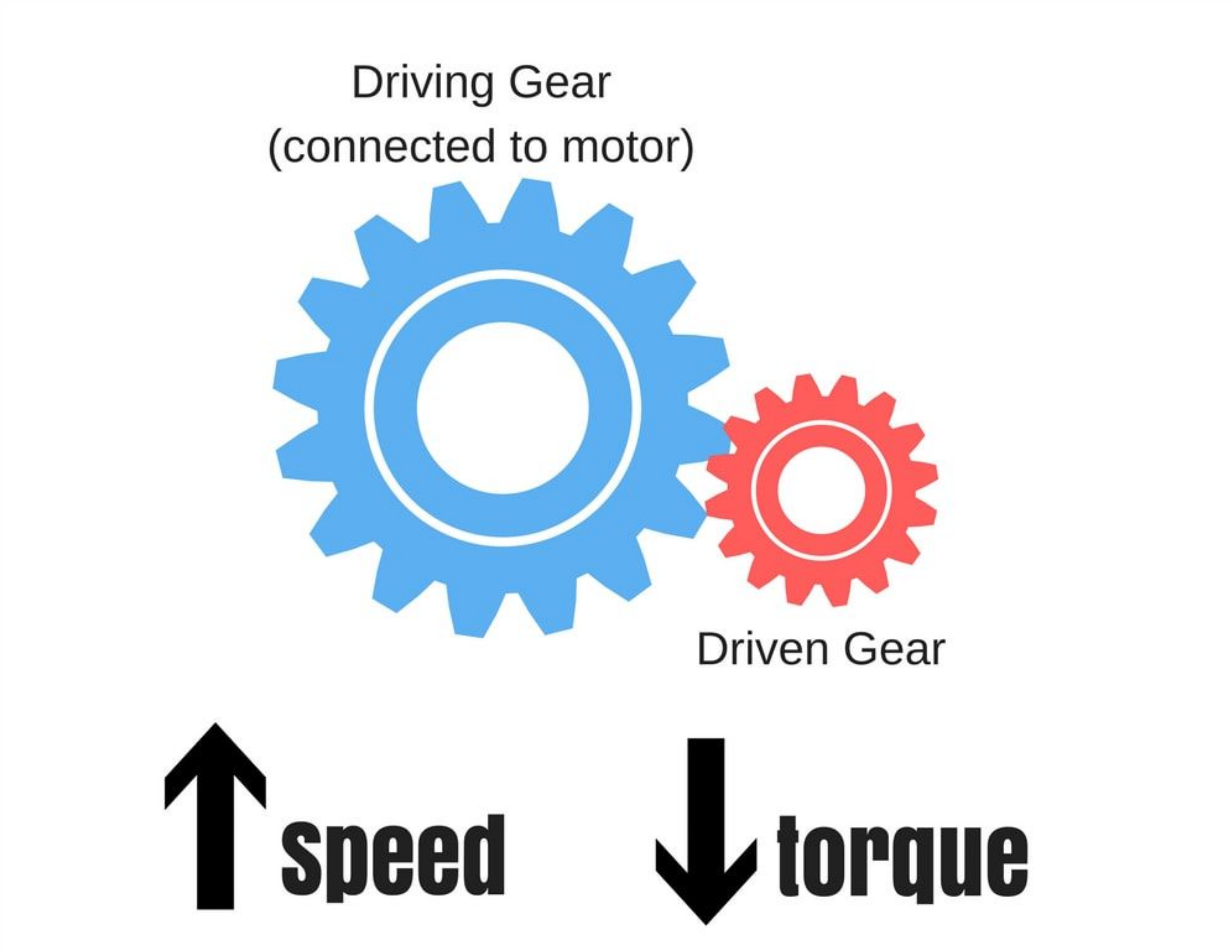
Increasing Speed (lowering torque) is a gear ratio where the driving gear has **more teeth** than the driven gear.

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



Chassis Redesign Part 2

When a larger gear connects to a motor and meshes with a smaller gear, the result is an increase in rotational speed. This occurs because the smaller gear, having fewer teeth, rotates at a higher rate when driven by the motor. However, this speed boost comes at the expense of torque, which is the twisting force exerted by the gears. Torque decreases as the speed increases in this gear configuration, as the smaller gear's faster rotation results in diminished force and reduced rotational power. Additionally, when two gears mesh, they rotate in opposite directions.

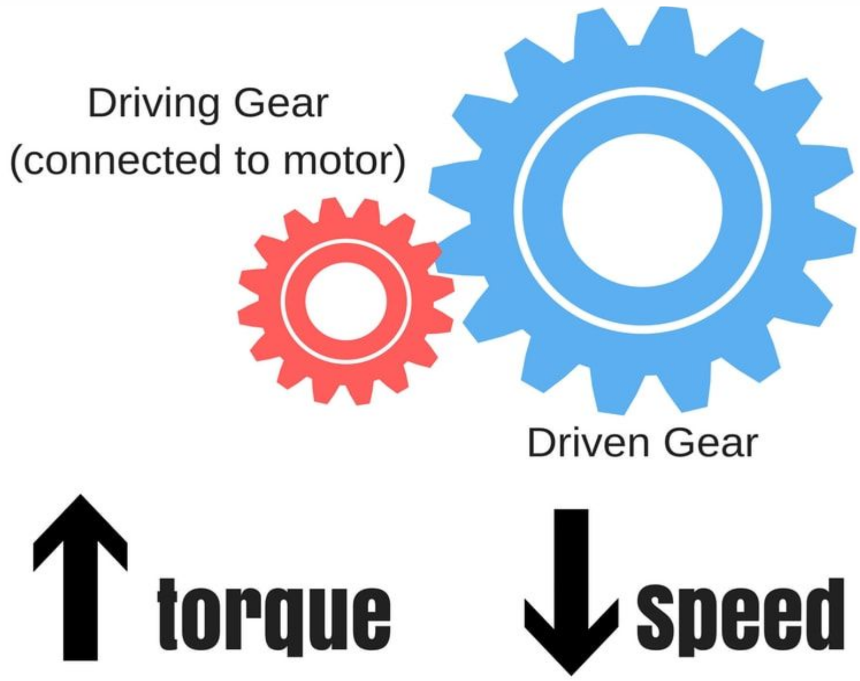


Source: https://cariwilliamzvex.weebly.com/gear-ratios.html

Chassis Redesign Part 2

When a smaller gear is connected to a motor, and it meshes with a larger gear that is driven, the result is a reduction in rotational speed. This occurs because the larger gear, with its greater number of teeth, rotates at a slower pace compared to the smaller gear when powered by the motor. This gear arrangement, which deliberately slows down speed, concurrently enhances torque, the twisting force exerted by the gears. This controlled reduction in speed is often desired in many mechanical applications to increase the torque within the gear system. Torque and speed are inversely related in such setups, meaning that as the larger gear's rotation decelerates, the gear system's capacity to generate force and rotational power intensifies.

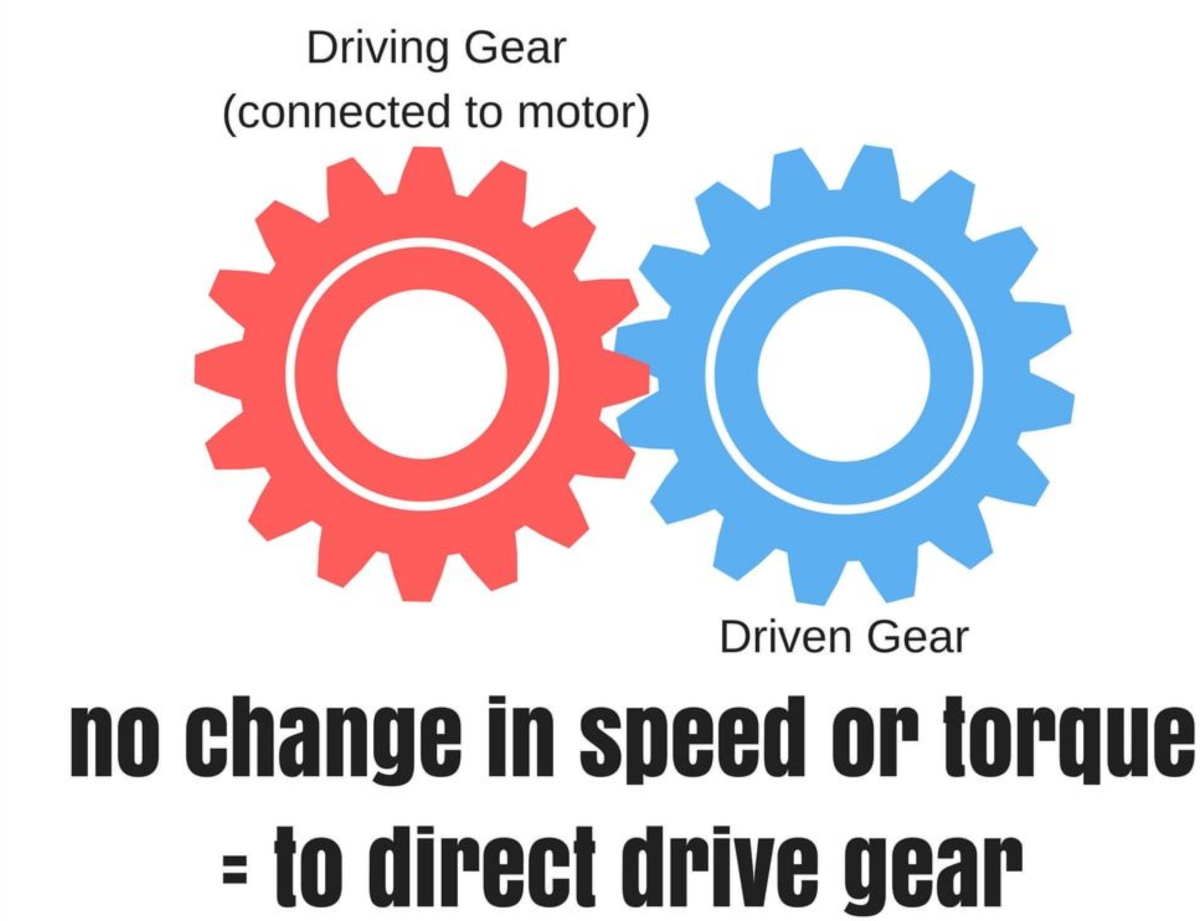
Additionally, it's important to note that when two gears mesh, they invariably rotate in opposite directions, which is a fundamental principle in understanding gear systems and their role in motion and power transmission.



Source: https://cariwilliamzvex.weebly.com/gear-ratios.html

Chassis Redesign Part 2

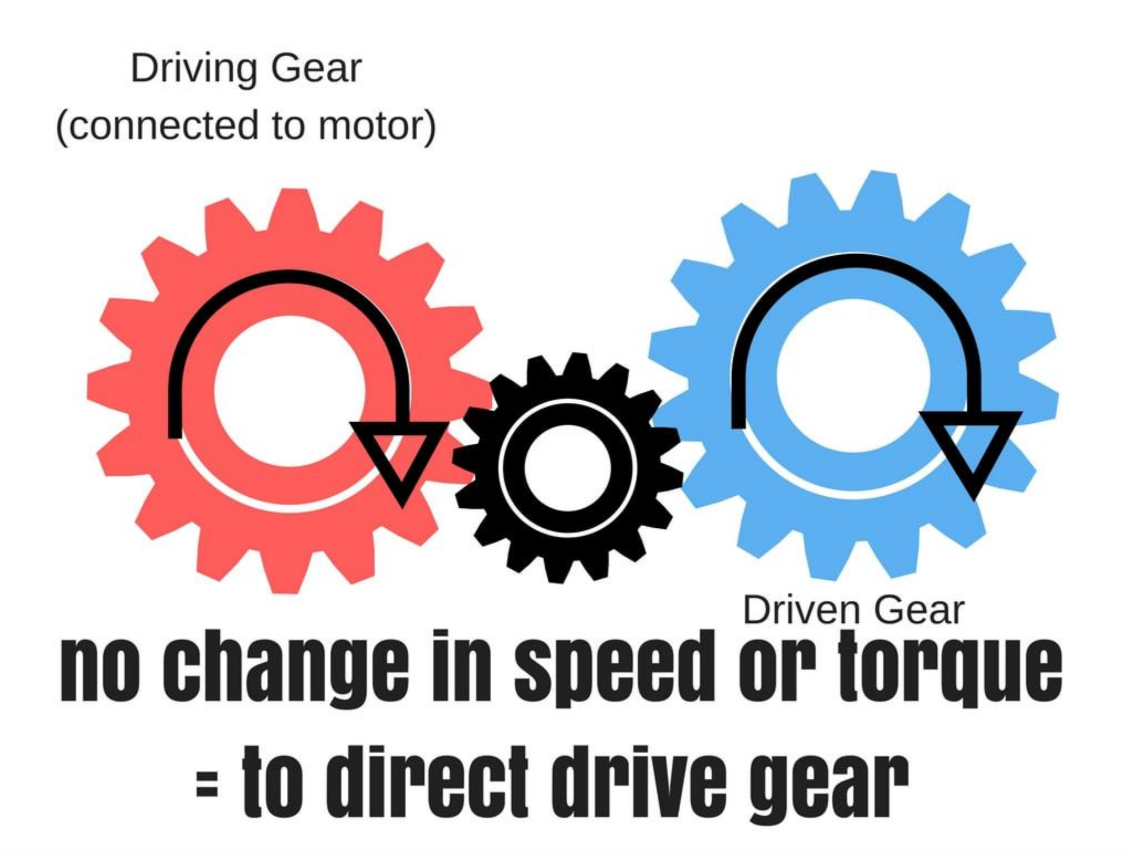
Gears of the same size meshed together result in no change in speed or torque, making them useful for motion transfer in robots. This ensures that the driven gear matches the speed and torque of the driving gear. This approach simplifies design, provides synchronization, offers redundancy, and enhances reliability in various robotic applications. However, not all robots require gears of the same size, as different-sized gears with specific gear ratios may be necessary for specific speed and torque adjustments.



Source:
https://cariwilliamzvex.weebly.com/gear-ratios.html

Chassis Redesign Part 2

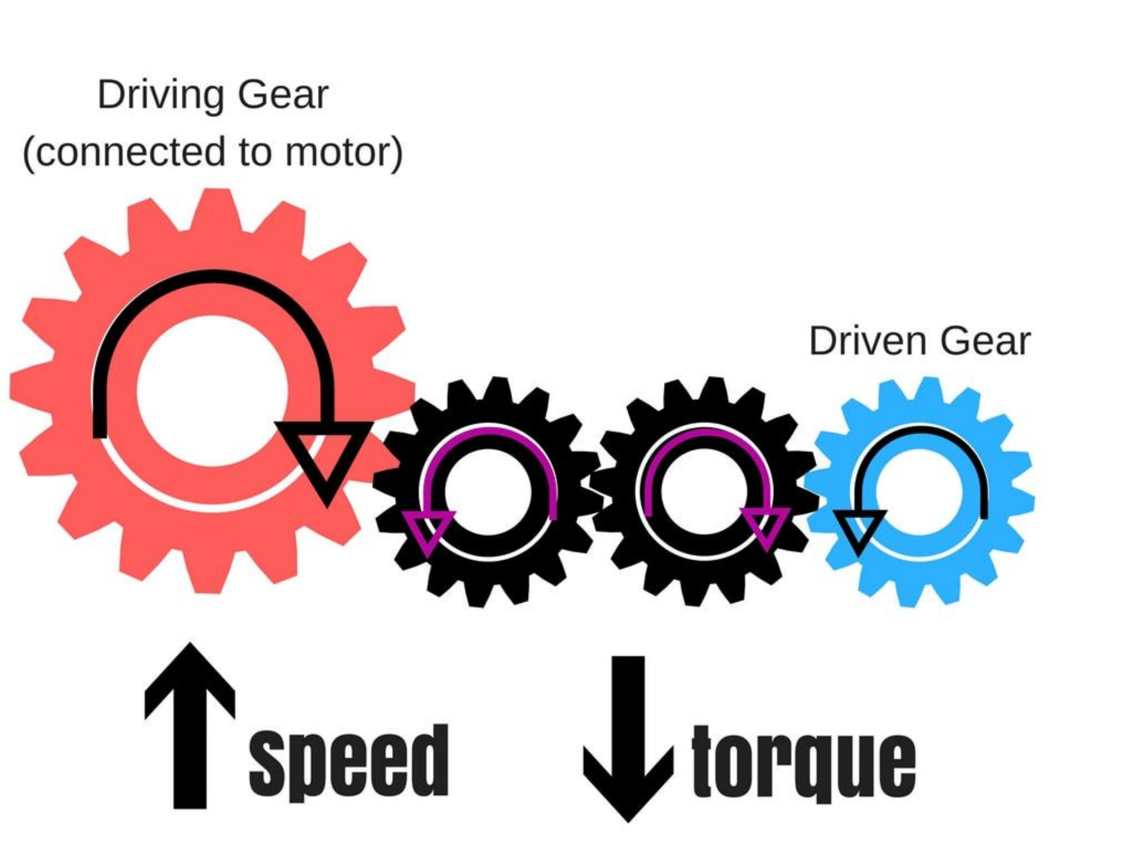
In certain mechanical systems, an additional gear known as an "idler gear" is strategically introduced. This idler gear, unlike the driving and driven gears, does not serve to change the speed or torque of the system. Instead, its primary function is to alter the direction of rotation of the driven gear. When a single idler gear is interposed between two other gears in a transmission system, it effectively synchronizes their movements, causing the driving gear and the driven gear to rotate in the same direction. The size of the idler gear, in terms of its diameter and number of teeth, is not a critical factor when determining the gear ratio for speed and torque. Therefore, the idler gear size doesn't directly influence the speed or torque characteristics of the system but is primarily a means of achieving mechanical synchronization or changing rotational direction.



Source: https://cariwilliamzvex.weebly.com/gear-ratios.html

Chassis Redesign Part 2

Sometimes several idler gears are used to transfer motion to another part of the robot.



Source:
https://cariwilliamzvex.weebly.com/gear-ratios.html

Improving Chassis

Today's Goals:

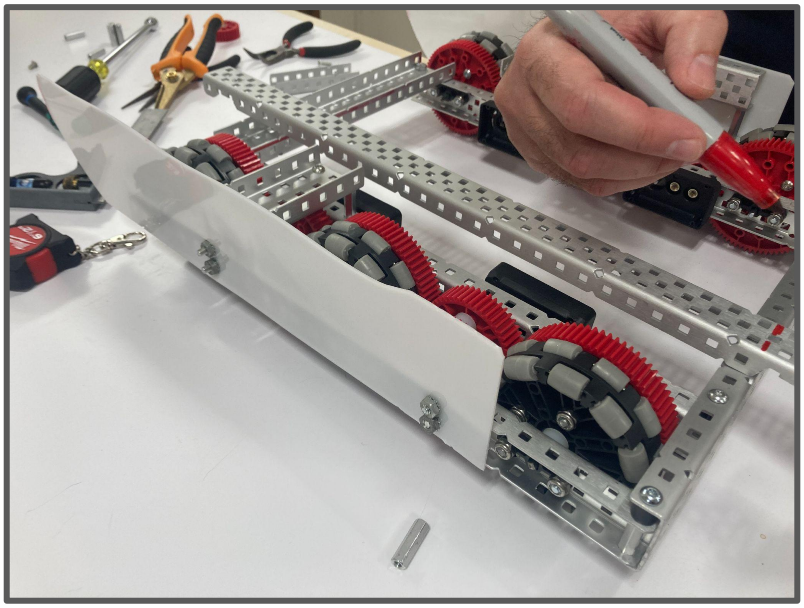
1. Add side guards
2. Attach brain, battery, radio, motors
3. Test robot on field

Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 9/30/23, 10am-4pm

We added side guards to the chassis we finished building last weekend. We also attached the brain, battery, radio, and motors. Towards the end of the meeting we tested our robot on the field to make sure it didn't get stuck.



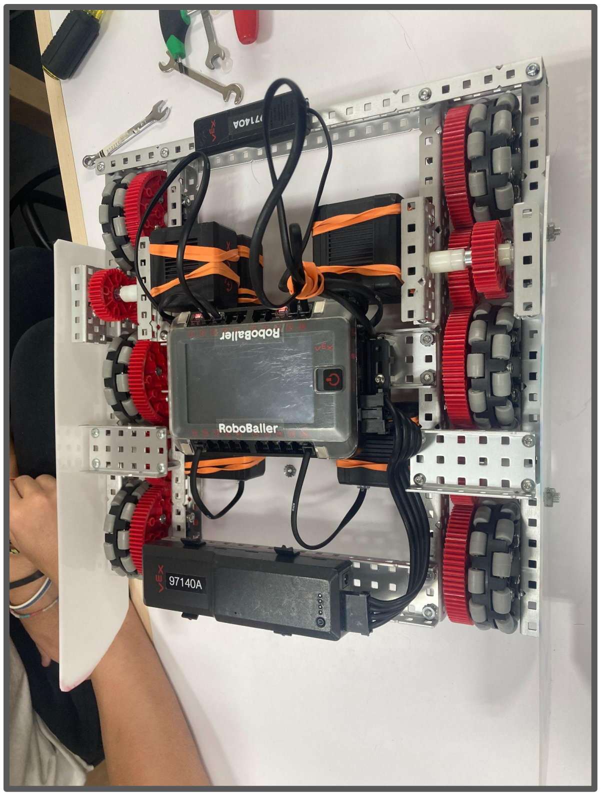
Improving Chassis Pt 2:

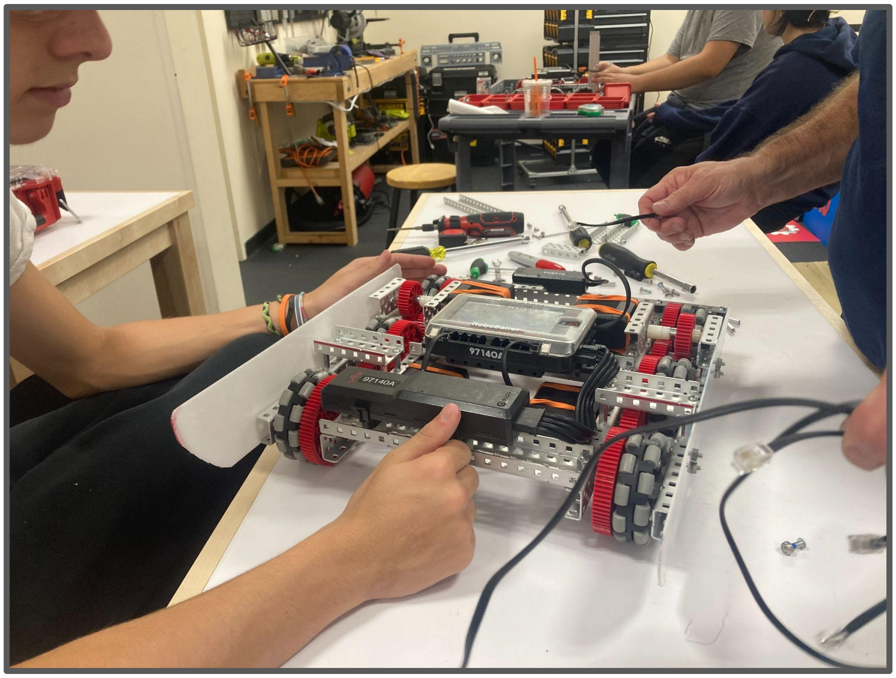
Side Guards

Problem: Delrin side guards were not secured properly and kept moving; made robot less effective.

Solution: Add stanoffs to hold delrin in place.
We used two one inch standoffs and ¼ inch screws to secure the delrin. It made it move less which was better when driving. We tested this on the field with a few triballs to make sure that we chose the best solution.

Side skirts/guards are created with long strips of plastic that run along the sides of a robot. These, in essence, are used to prevent things on the field from getting under the robot, providing a solid block that nothing can pass through. Side skirts/guards are ideal for preventing small game elements and other robots, especially, from getting under a chassis.
Ideally, side skirts should be braced as low to the ground as possible, to prevent something trying to get under a robot from bending or breaking the plastic.





Improving Chassis:

Adding Side Guards

Problem: Robot can get stuck on different field parts. Robot can't maneuver triballs as easily towards intake as we had hoped.

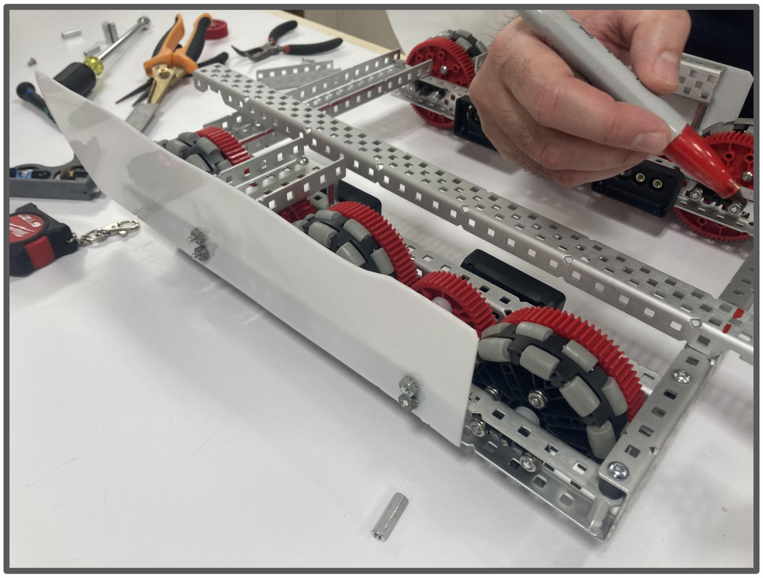
Ideas:

1. Rebuild the front of the robot to include arms that would make gathering tri balls easier.
2. Add side guards to "channel" in the tri balls.

Decision Matrix

	Rebuild	Side Guards
Maneuverability	4	5
Ease of build	2	4
Effectiveness	5	5
Total	11	14

Based off our design matrix, we decided that adding side guards would be easier. There are two different plastics that we use interchangeably based off of what is in stock and easiest to get. They are discussed on the next few pages.For our build we used delrin. We cut out two identical rectangular pieces. We then cut a diagonal on the tip of each that was about 2 ½ inches long.



Improving Chassis: Side Guards- Polycarbonate

Translucent Smoke Grey Polycarbonate (also known as Lexan or Makrolon) is a tough plastic that can improve the look of your robot. It offers endless possibilities in your robot design and is easy to work with. Sheets can be cut easily (even tin snips work well for small pieces) and can be cold-bent or heated and bent. This 1/16" thick sheet is the maximum thickness that is legal in the VEX Robotics Competition. Use Smoke Grey color for decorations, side panels, or to feature sponsor logos. Legal for use on competition robots: Rule R9 permits plastic from one 12x24x0.070" sheet.

Polycarbonate is a superior clear plastic sheet compared to Plexiglass/Acrylic
Sheets can easily be cut, milled, and drilled with any standard tools (hacksaw, jigsaw, snips for thin sheets, standard drill bit, etc.) without the cracking or fracturing you would find in Plexiglass. Additionally, Polycarbonate can be bent neatly. Thin sheets can be bent cold with sheet metal techniques, while thicker ones are easy to shape with the help of a heat gun. It is also perfect for thermoforming or vacuum forming. This makes Polycarb perfect for both DIY and professional projects around the home, shop, or for manufacturing.

Shatter Resistant & Strong
Polycarbonate has great mechanical properties, making it often considered as a safer option than glass sheets or acrylic sheets. Tensile Stress: 63 MPa. Flexural Stress: 90 MPa. Rockwell Hardness, R: 120

Electrical Resistance
Volume Resistivity: > 1.0E15 Ohm-cm

Protective Film on BOTH SIDES
This product is shipped with a thin protective film on both sides. Please peel this off to expose the clear sheet. You can mark onto this film while working with the material, then remove it to expose a pristine surface.

Improving Chassis: Side Guards- Polycarbonate

Legal for use on competition robots: Rule R9 permits plastic from one 12x24x0.070" sheet.

Compatibility with your laser cutter may vary. Before laser cutting, consult with your machine's manufacturer to determine if Acetal Copolymer (also known as Delrin, POM, or polyoxymethylene) is a suitable material and to ensure that all necessary safety precautions such as adequate ventilation are in place.

Acetal is often sold under the brand Delrin®. Acetal sheets are known for their strength & low friction, featuring an exceptional combination of durability, stiffness, strength and lubricity

- Laser cutting lets you bridge the gap between CAD and quick physical prototyping when learning the engineering design process. In just minutes you can design a part, precisely manufacture it, test, adjust, and repeat
- Clear PE protective film can be left on during cutting
- Sheets can also be cut and bent (cold or heated and bent) like polycarbonate or ABS
- Acetal copolymer
- White color

Source: Robosource.net

Improving Chassis:
Adding Radio and Brain

The next thing we did was mount the radio and brain on our robot. We also attached the brain clips using four screws on a plate to the side of the robot.

Mounting the Radio

To mount the radio we cut an aluminum plate down to 4x2 holes. We used two screws to attach the radio to the plate, and two more screws with two nuts to attach the ratio and plate to the back top right of the robot.

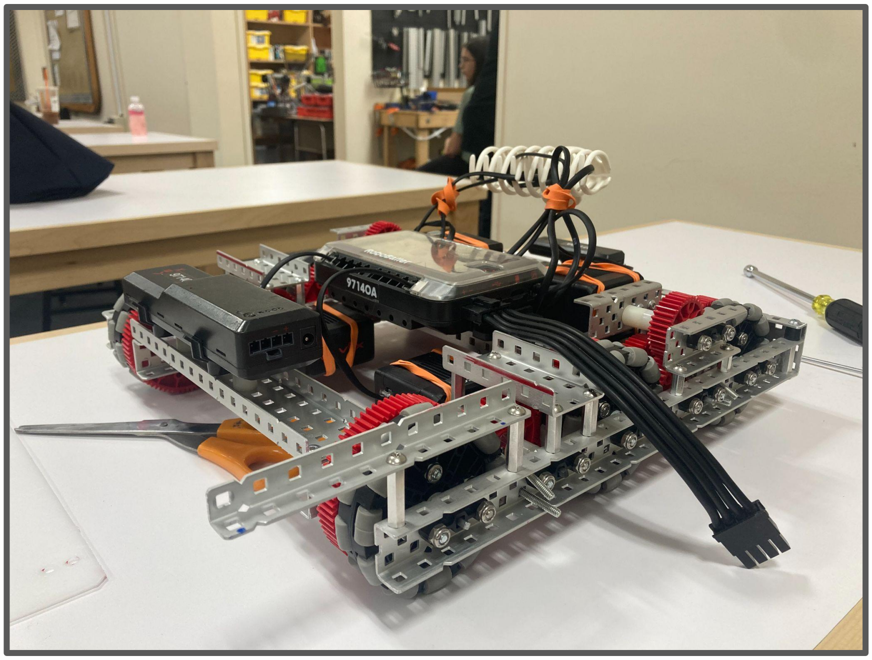
Mounting the Brain

To mount the brain we used an aluminum angle cut down to 7 holes. We attached the brain onto it using three screws, and then attached the angle to a plate with two more screws and nuts.

Improving Chassis Part 2

Today's Goals:

1. Fix shaft collar
2. Reinforce sides
3. Attach arms
4. Label motors
5. Begin building catapult



Who was here:

- Matt
- John
- Lazaro

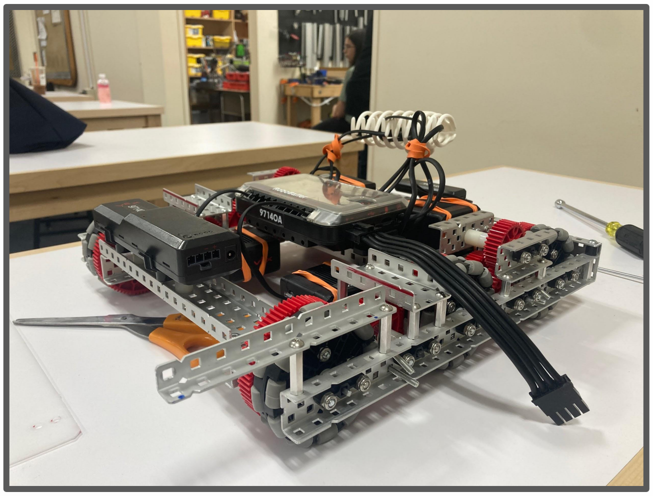
Time and date: 10/1/23, 12pm-4pm

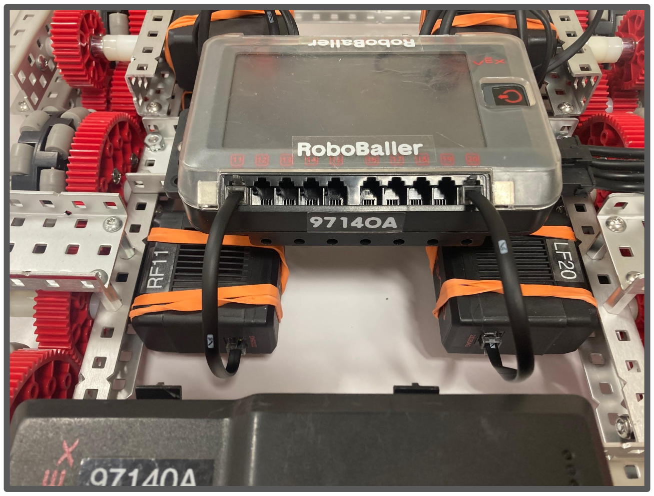
We began by assigning and labeling the motors. To label them, we used a label machine and cut each down to size. They we labeled left or right and top or bottom. We also reinforced the white guards we made out of delrin with extra screws and standoffs. We also attached arms and towards the end of the meeting, and thought about ideas for the catapult. We also made and brought in Bart!

Improving Chassis Part 2:

Labeling Motors

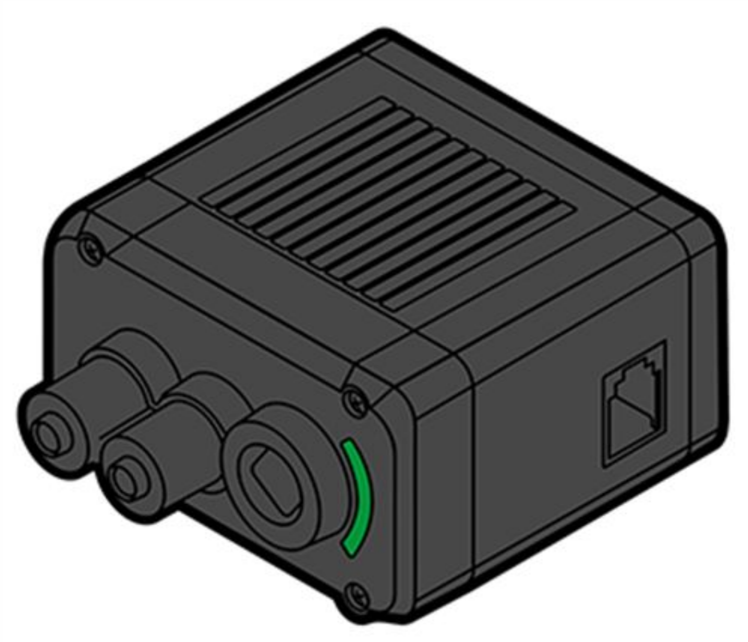
The first thing we did today was label the motors. It makes it easier to keep track of each when programming and working with the robot. To label them, we created labels for each and printed them out. The different labels were LF20, LB10, LT9, RF11, RB, and RT3. Lf stands for left front, LB stands for left back, LT stands for left top, and the same for right. The functions and designs of the motors are discussed on the next few pages.





Improving Chassis Part 2:

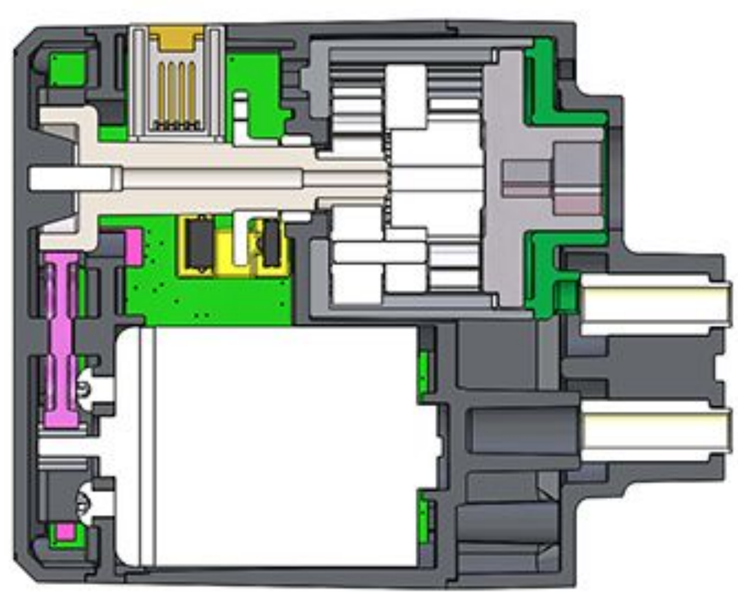
V5 Motors



Function

The V5 Smart Motor is the product of thousands of hours of engineering and analysis aimed at perfecting the gears, encoders, modular gear cartridges, as well as the circuit board, thermal management, packaging, and mounting. This thoughtful design allows us to control the motor's direction, speed, acceleration, position, and torque that turn the robot's wheels, arms, claws, or any movable component. The V5 Smart Motor provides feedback data about its position, velocity, current, voltage, power, torque, efficiency, and temperature.

- The V5 Smart Motor's internal circuit board uses a full H-Bridge and its own Cortex M0 microcontroller to measure position, speed, direction, voltage, current, and temperature. The microcontroller runs its own PID (proportional–integral–derivative) with control over the velocity, position, torque, feedforward gain, and motion planning similar to industrial robots. The PID is internally calculated at a 10-millisecond rate and the PID values are pre-tuned by VEX for consistent performance across all operating conditions.



Source: Home - VEX Robotics

Improving Chassis Part 2:

V5 Motors

Integrated Control System

- Users can adjust the motor's PID values to tune a motor's performance for more advanced mechanical systems. Advanced users can bypass the internal PID and take direct control with raw, unaltered PWM (pulse-width modulation) control. PWM, like PID control, still has the same limits that keep the motor's performance consistent.
- Additional control of the V5 Smart motor is achieved by internal encoders. These measure the amount of rotation of the shaft socket. The rotation is divided into a number of steps or “ticks” which provides feedback as to the amount a shaft has turned. The resolution of the encoder is determined by the internal gear cartridge of the motor.

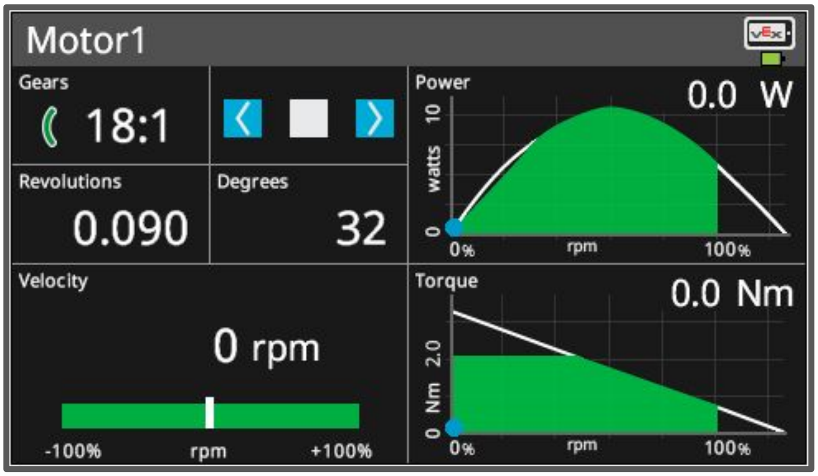
Encoder	1800 ticks/rev with 36:1 gears 900 ticks/rev with 18:1 gears 300 ticks/rev with 6:1 gears

- The V5 Smart Motor is completely consistent in its performance. The motor runs internally at a slightly lower voltage than the V5 Robot Battery's minimum voltage, and the motor's power is accurately controlled to +/-1%. This means the motor will perform the same every time, regardless of the battery's charge or the motor's temperature.
- The motor's internal temperature is monitored to make sure the motor lasts. If the motor starts to overheat, there is a warning. If the motor reaches its temperature limit, performance is automatically reduced to ensure no damage occurs. The motor has four levels of response to rising temperatures. Each temperature level limits the motor current: level 1 = 50% current, 2 = 25% current, 3 = 12.5% current, 4 = 0% current.

Source: [Home - VEX Robotics]

Improving Chassis Part 2:

V5 Motors



- The motor calculates accurate output power, efficiency, and torque. It also reports its position and angle with an accuracy of 0.02 degrees. Those calculations and other data are reported and graphed on the V5 Robot Brain's motor dashboard, as shown above.

Note: Be sure the gear ratio displayed in the Gears frame of the motor window matches the V5 Smart Motor Cartridge the motor is paired with. The gear ratio display can be changed by touching the Gears frame on the touch screen.

- The V5 Smart Motor ports are illuminated with a red LED for visual communication.

No red light	No connection made with a V5 Brain which is powered on.
Solid red	There is a connection made with a V5 Brain which is powered on and communicating.
Fast flashing red	Indicates which motor is connected to a port which has been selected in the V5 Brain's Device Info Screen.
Slow blink red	Indicates there is a communications fault.

- The motor's #8-32 Threaded Inserts can be flipped over in the motor's housing and this will make them flush with the housing rather than slightly protruding. This is useful when the motor will not be mounted directly to a piece of structural metal. For example, this will allow the motor to be mounted using standoffs.
- There are replacement parts for the motor. These include the V5 Smart Motor Cap Replacement and the V5 Smart Motor #8-32 Threaded Inserts. Parts which can be used to repair a motor so an entire motor does not need to be replaced when it's damaged.
- The motor's shaft socket can accommodate a High Strength Square Gear Insert.

Source: [Home - VEX Robotics]

Improving Chassis Part 2:

V5 Motors

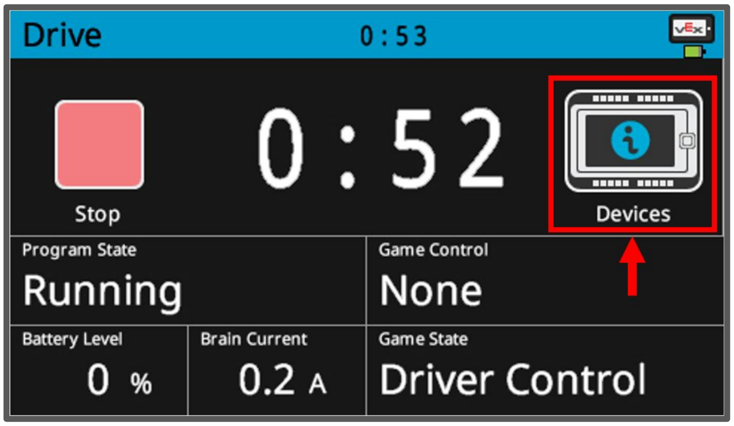
How it improves the user experience

- Aside from the control and consistency that the V5 Smart Motor supplies, the motor has easy-to-replace internal gear cartridges for output gear ratios of 36:1 (100 rpm) for high torque & low speed, 18:1 (200 rpm) for standard gear ratio for drive train applications, and 6:1 (600 rpm) for low torque & high speed which is best used for intake rollers, flywheels, or other fast moving mechanisms. This makes the V5 Smart Motors faster than the previous 393 Motors. For more information, please refer to: How to Change a V5 Smart Motor Gear Cartridge.
- Whereas the 393 Motor maintained only 2.7 watts of continuous power and peaked at 3.93 watts, the consistent 11-watt power levels during both peak and continuous performance enhance the stability of the V5 Smart Motor.
- While the battery is low, the V5 Smart Motor continues to put out 100% power, unlike the 393 Motor which reduced to only 51% power under low battery conditions. This greatly improves the V5 Smart Motor's consistency, especially in combination with other previously explained enhancements.
- As previously explained, the V5 Smart Motor provides feedback data related to position, velocity, current, torque, temperature, etc. This is a great improvement over the 393 Motor that only provided feedback related to its position. The V5 Smart Motor's feedback system provides a user with the information needed to then iterate on their robot and program. These are valuable learning opportunities for new robotics students who can then account for these factors within their designs, and for more experienced robotics students who can visually see the relationships and dynamics within the motor's functioning.

Source: Home - VEX Robotics

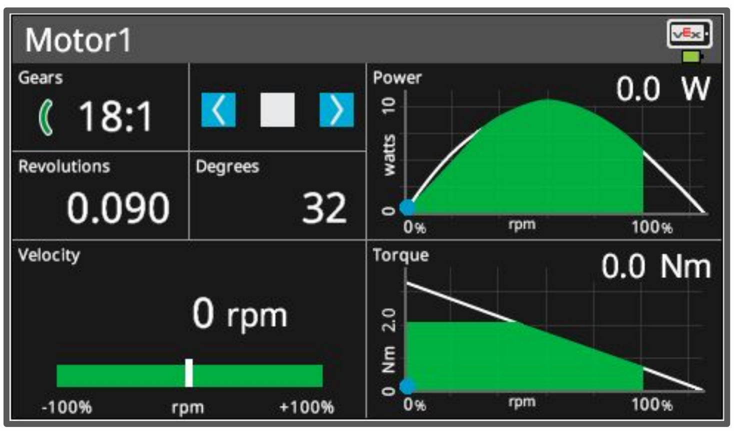
Improving Chassis Part 2:

V5 Motor Dashboard



Click on Devices while a program is running.

Choose the V5 Smart Motor to see its Motor Dashboard.



Review the data provided
Note: Be sure the gear ratio displayed in the Gears frame of the motor window matches the V5 Smart Motor Cartridge the motor is paired with. The gear ratio display can be changed by touching the Gears frame on the touch screen.

Source: [Home - VEX Robotics]

Improving Chassis Part 2:

Mini Motors

We received the mini motors a week ago. We took them apart to better understand the mechanics of the motors, and help us understand how we could incorporate them into our design. They are discussed more on the next few pages.

The EXP Smart Motor (5.5W) is capable of producing half the power of the original V5 Smart Motor (11W). Perfect for low-RPM or lightweight applications such as indexers, arms, or some intakes.

Note: This motor operates at a set RPM, and is *not* compatible with V5 Smart Motor cartridges.

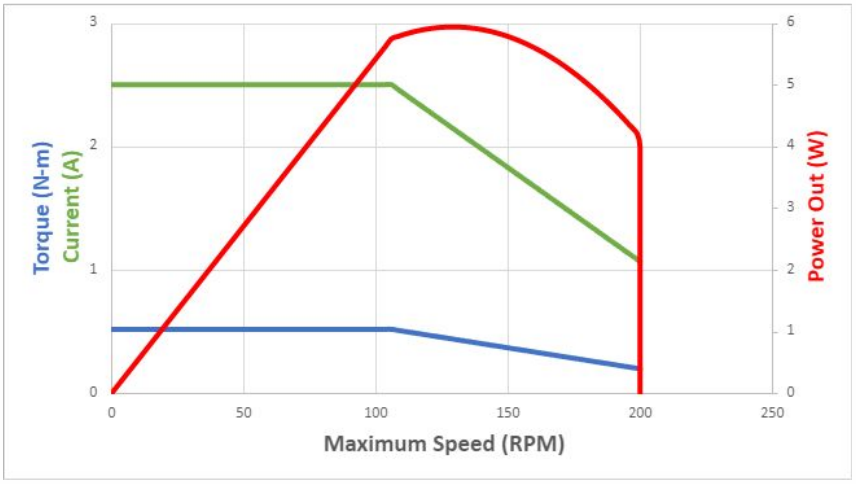
Source: Home - VEX Robotics

Improving Chassis Part 2:

Mini Motors

The meticulous design and high performance of the V5 Smart Motor (5.5W) were instrumental to its successful implementation and widespread adoption. Thousands of hours of engineering and analysis went into designing this motor. Everything has to work together: the motor, gears, encoder, circuit board, thermal management, packaging and mounting. Users can control the motor's direction, speed, acceleration, position, and torque limit.

This graph says it all. Maximum power is 5.5W continuous and maximum torque is 0.5 Nm. Free speed is software-limited by the motor's processor to keep consistent performance motor-to-motor and to allow top speed under loads.



Source: [Home - VEX Robotics]

Improving Chassis Part 2:

Mini Motors

The motor's internal circuit board has a full H-Bridge and its own Cortex M0 microcontroller to measure position, speed, direction, voltage, current and temperature. The microcontroller runs its own PID with velocity control, position control, torque control, feedforward gain, and motion planning similar to industrial robots. PID is internally calculated at a 10 millisecond rate. The motor's PID values are pre-tuned by VEX for excellent performance across all operating conditions.

Advanced users can bypass the internal PID and take direct control with raw, unaltered PWM control. Raw control still has the same rpm limits, current limits, and voltage maximum that keep the motor's performance identical.

"Consistent motor performance is a game changer"

One of the V5 5.5W Smart Motor's most unique capabilities is completely consistent performance. The motor runs internally at a slightly lower voltage than the battery's minimum voltage, and the motor's power is accurately controlled to +/-1%. This means the motor will perform the same for every match and every autonomous run, regardless of battery charge or motor temperature.

Stall current is limited to 2.5A to keep heat under control without affecting peak power output. Limiting stall current eliminates the need for automatic resetting fuses (PTC devices) in the motor, which can cause unintended motor outages. The 2.5A limit essentially removes the undesirable region of the motor's performance curve, ensuring users do not unintentionally create stall situations. Finally, to make sure the motor lasts, the internal temperature is monitored. If a motor is approaching an unsafe temperature, the user gets a warning. If the motor reaches its temperature limit, performance is automatically reduced to ensure no damage occurs.

The motor calculates accurate output power, efficiency, and torque, giving the user a true understanding of the motors performance at any time. Position and angle are reported with an accuracy of .02 degrees. All of this data is reported and graphed on the motor's dashboard.

Improving Chassis Part 2:

Mini Motors

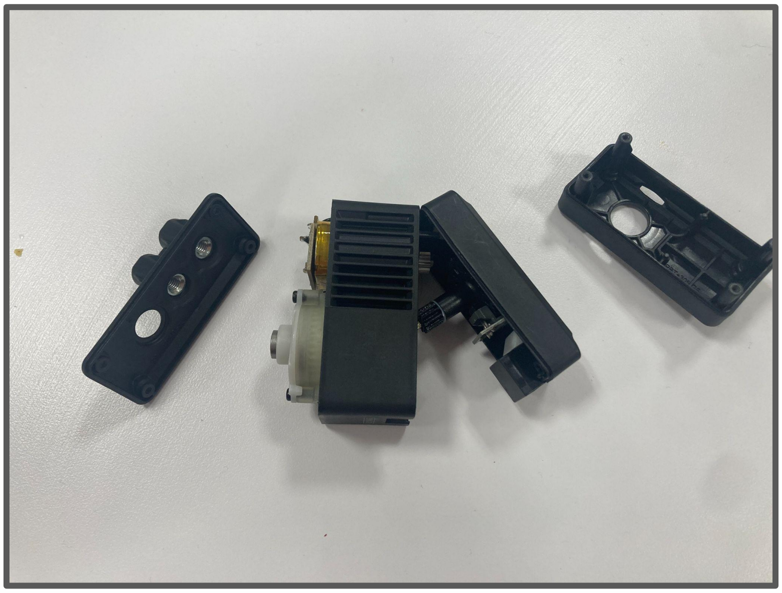
Motor Name	V5 Smart Motor (11W)	V5 Smart Motor (5.5W)
Part Number	276-4840	276-4842
Peak Power	11W	5.5W
Gear Cartridge Ratios	35:1 18:1 6:1	Fixed
Speed (RPM)	100 with 36:1 Cartridge 200 with 18:1 Cartridge 600 with 6:1 Cartridge	200
Stall Torque (Nm)	2.1 with 36:1 Cartridge	0.5
Feedback	Position Current Voltage Power Torque Efficiency Temperature	Position Current Voltage Power Torque Efficiency Temperature
Encoder	1800 ticks/rev with 36:1 gears 900 ticks/rev with 18:1 gears 300 ticks/rev with 6:1 gears	900 ticks/rev
Dimensions	2.26" W x 2.82" L x 1.30" H (57.3 mm W x 71.6 mm L x 33.0 mm H)	2.25" W x 2.5" L x 1" H (56.8mm W x 63.4mm L x 25.1mm H)
Weight	0.342 lbs (155 grams)	0.25 lbs (114 grams)

Source: [Home - VEX Robotics]

Improving Chassis Part 2:

Mini Motors

Motor Programming		
Settings	Actions	Sensing
Motor.setVelocity()	*Motor.spin()*	*Motor.isDone()*
Motor.setTorqueLimit()	*Motor.stop()*	*Motor.direction()*
Motor.setStopping()		*Motor.rotation()*
Motor.setRotation()		*Motor.velocity()*
Motor.setTimeout()		*Motor.current()*
		Motor.power()
		Motor.torque()
		Motor.efficiency()
		Motor.temperature()



We considered using mini motors for our robot, which is why we heavily discussed them. They would be useful for smaller parts of our robot such as the catapult. We didn't even think about using them for the drivetrain, as that would not be beneficial.

Source: [Home - VEX Robotics]

Catapult Prototype

Today's Goals:

1. Begin brainstorming catapult
2. Try building the first iteration
3. Replace screws

Who was here:

- Matt
- John
- Lazaro

Time and date: 10/7/23, 10am-4pm

We began by researching a few different catapult designs. We had already decided to the beginning of the season that we wanted a catapult. To make sure we looked back on our design matrix. We came up with a few ideas and began brainstorming. We had one main idea after watching more competition footage and began building it.

Decision Matrix

	Flywheel	Catapult
Accuracy	3	4
Effectiveness	3	4
Speed	3	5
Weight	2	4
Build Complexity	3	3
Programming	3	3
Total	17	23

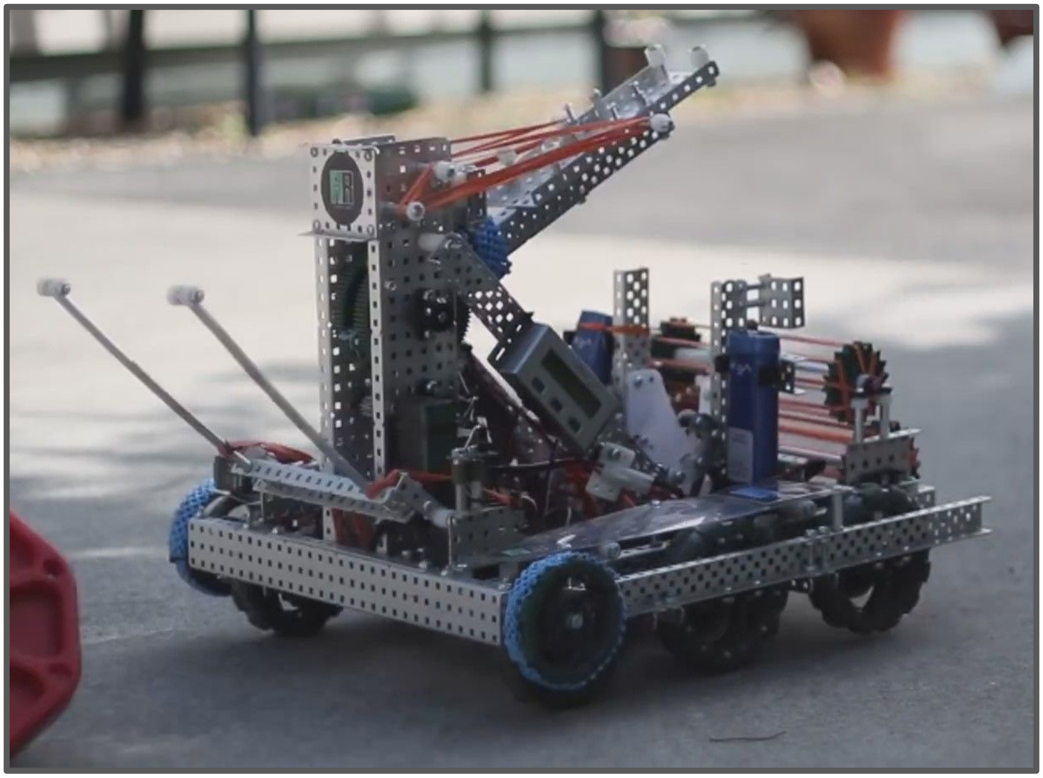
Catapult Prototype:

Ideas and Considerations

<u>What is a catapult?</u>

A catapult is a launching mechanism that utilizes rotational movement in order to fire objects. This is achieved by rotating an arm where an object placed at the end will gain momentum in the desired direction, and abruptly stopping the arm so that the object will continue its trajectory through the air. In VEX, catapults are often chosen because of their versatility, as they are able to easily launch any object regardless of shape or size, as well as being able to launch multiple objects simultaneously. Catapults have made several appearances throughout previous games, such as the 2013-2014 game Toss Up and the 2018-2019 game Turning Point.

There are two different types of catapults: elastic and pneumatic. They are discussed on the following pages.



Source: wiki.purduesigbots.com

Catapult Prototype:

Ideas and Considerations

Elastic Catapult

Catapults powered by elastics (rubber bands, surgical tubing, etc.) are the most versatile and widely used method of applying force. There are many reasons why this is a popular design choice, however there are some *drawbacks*.

Pros	Cons
Easy to tune force by changing the amount of rubber bands	Places a large amount of stress on the robot due to the tension of the rubber bands
Force stays consistent throughout a match	Rubber bands need to be replaced often outside of matches
Can be powered a variety of ways	Requires lots of force to draw the catapult back

One of the benefits listed above was the ability to power an elastic catapult through a variety of ways, which are discussed below.

Slip Gears

Slip gears are one of the ways where the rotational force of a motor is utilized to draw back and fire an elastic catapult. A slip gear is a gear that has several consecutive teeth shaven off, so that another gear driven by the slip gear will "slip" when it rotates to the section of the slip gear that has no teeth. Slip gears are often used in tandem with ratchets, to reduce the load on motors. These components are also commonly used in linear punchers

Source: wiki.purduesigbots.com

Catapult Prototype:

Ideas and Considerations

Elastic Catapult

For elastic catapults, the arm of the catapult is attached to a gear that is being driven by a slip gear. When the slip gear is rotated so that the shaven teeth are not engaging with the gear of the catapult, the catapult arm is able to rotate freely, allowing the built up tension from the elastics to rotate the catapult in the opposite direction.

Gear Ratios

The more elastic force applied on a catapult, the more torque the motor will need to provide in order to draw back the catapult. To accomplish this, gear ratios can be used to increase the output torque of the motor. For most catapults, a simple gear ratio of 1:5 or 1:7 can be used with 100 rpm motors. However, compound gear ratios can be used to fine-tune the output torque of your motor, so that you can power your catapult more efficiently.

Additional Methods

Beyond slip gears, there are many other innovative ways to power a catapult which can be used to achieve the same effect:

Nautilus Gears/Cams

A nautilus gear/cams utilizes the changing outer radius to draw back the catapult, and fire when the radius drops off.

Source: wiki.purduesigbots.com

Catapult Prototype:

Ideas and Considerations

Pneumatic Catapult

Pneumatics can also be used in a catapult to launch objects, as the quick actuation in tandem with a lever arm can be used to send objects flying through the air. As with elastic catapults, there are many pros and cons to this type of catapult:

Pros	Cons
Does not place constant stress on the robot	Difficult to tune for a specific firing distance
Does not require long terms purchases to maintain (unlike elastic catapults)	Force gets weaker as the catapult is used (air runs out)
Does not require much force to draw back	Is limited to a specific range of motion

Optimization

Tuning a catapult to launch an object a specific distance can be tricky, so having the proper understanding of how certain factors can affect your shot can make a big difference in your catapult. There are three main aspects of a catapult that contribute to the arc of your object:

Rotational speed

The rotational speed of your catapult arm is the most obvious component of a catapult. The faster your arm swings, the faster your object will travel through the air. In VEX, the main contributor to the rotational speed is the amount of force that is being applied to your arm, whether it be rubber bands or pneumatic pressure. Increasing this will result in an increase in both the horizontal and vertical direction of your arc, and a decrease will do the opposite.

Source: wiki.purduesigbots.com

Catapult Prototype:

Ideas and Considerations

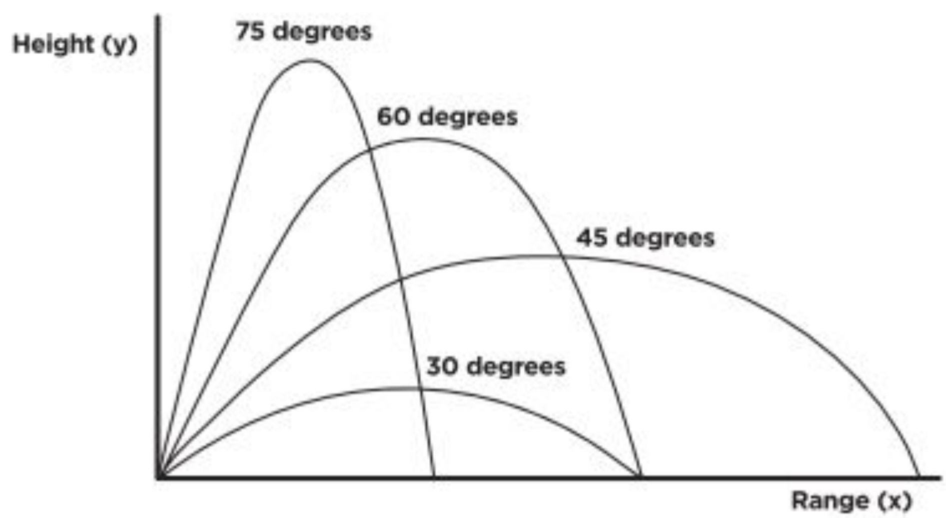
Pneumatic Catapult

Length of arm

The distance between the object and the point of rotation, or the catapult arm, is very closely related to the rotational speed, and has similar effects. If an arm has a constant *angular* speed, then an object placed farther away from the center will have a faster *linear* than an object placed closer to the center. Because of this, catapults with longer arms will be able to launch objects further, and vice versa

Launch angle

Tuning the launch angle of a catapult will allow you fine tune the trajectory of your ball. The vertical height and horizontal distance of your trajectory will have opposite responses to a change in the launch angle. For example, if you change the launch angle to increase the vertical height of your object, then the horizontal distance will decrease, and the same is true for the other way around. Below you can see a diagram of how different launch angles result in different heights and distances. In VEX, the launch angle of a catapult can be changed by implementing or changing the hard-stop of the catapult. The hard-stop is what prevents a catapult from rotating past a certain angle, so changing this angle will change the launch angle.



Source: wiki.purduesigbots.com

Catapult Prototype:

Ideas and Considerations

Decision Matrix: Elastic v. Pneumatic Catapult

Decision Matrix

	Elastic	Pneumatic
Tuning Ability	4	2
Force	3	4
Range	5	2
Stress	2	5
Maintenance	2	4
Power	5	2
Total	21	19

We continued to watch videos from a specific team that we liked along with some more competition footage. Based off of the design matrix above and the videos we decided on an elastic catapult. We didn't have much time to build so we decided to wait until tomorrow and instead decided to practice driving and loading tri balls onto the robot.

Catapult Design

Today's Goals:

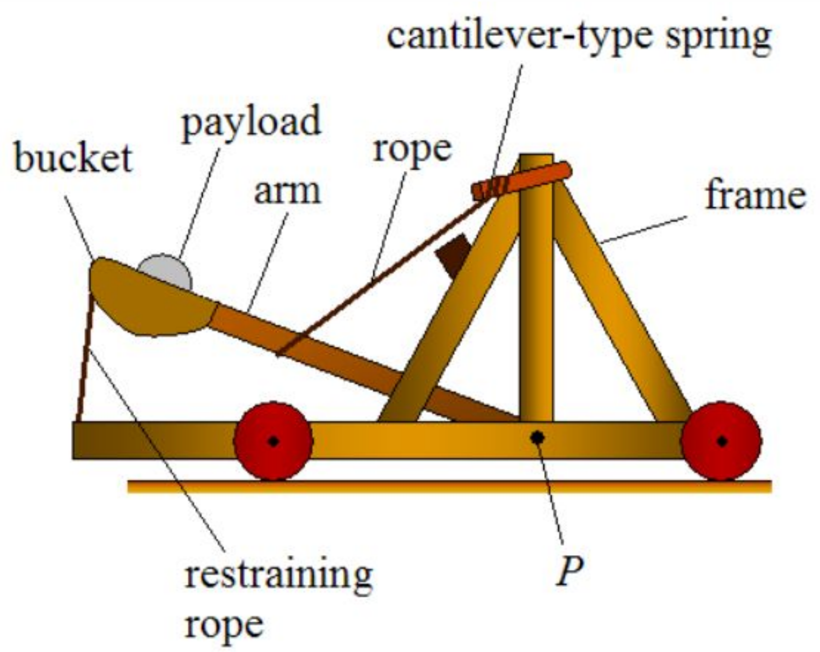
1. Finalize catapult design
2. Begin building catapult

Who was here:

- Matt
- John
- Lazaro
- Brenna

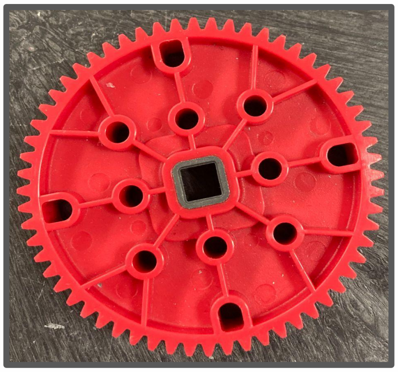
Time and date: 10/8/23, 12pm-4pm

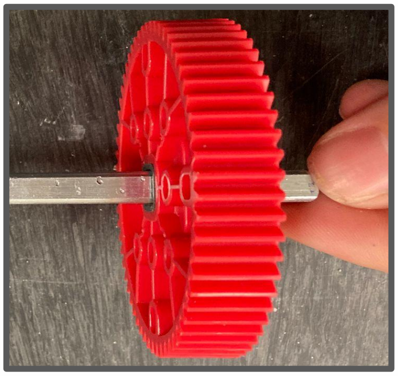
We began by finalizing out catapult design. We decided last meeting that we would use an elastic catapult. We began building the catapult. The catapult design is discussed on the next page.

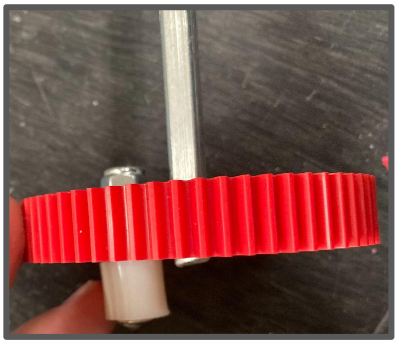


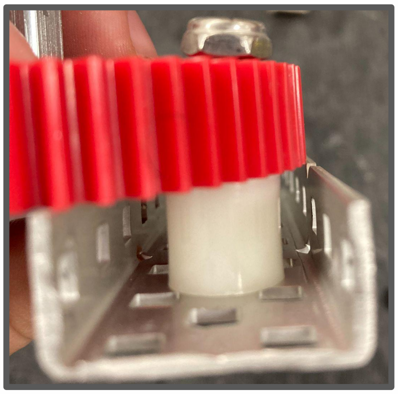
Basic diagram of an Onager, a type of catapult

Catapult Design



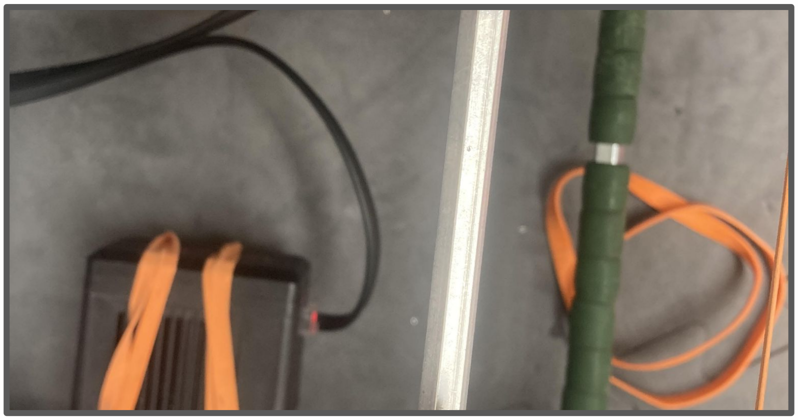


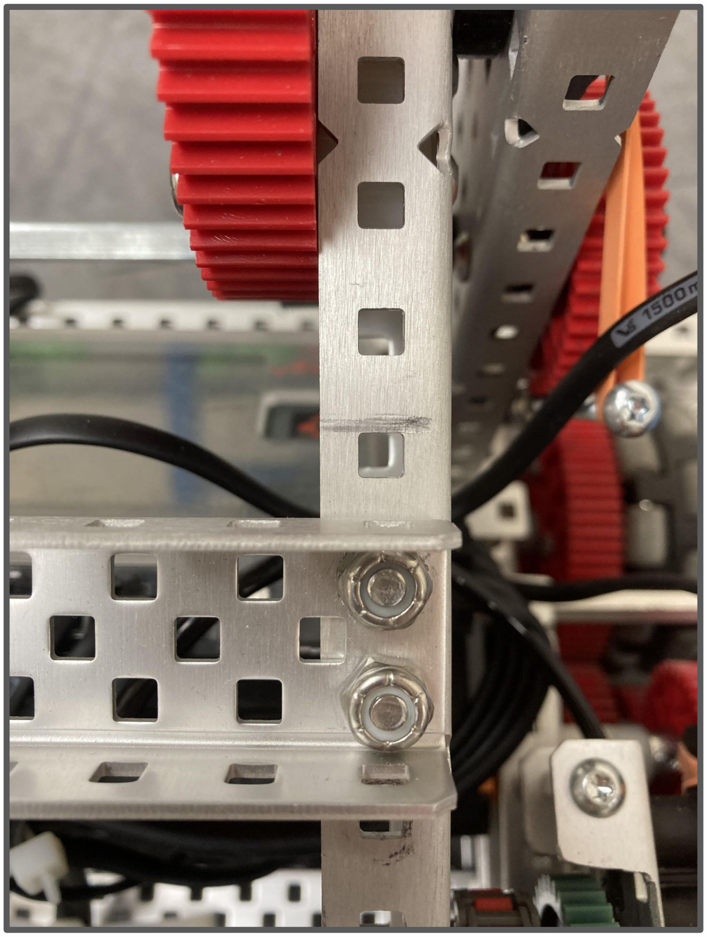




We began out catapult with two high strength gears. We put a high strength shaft in one and through the other. To connect each to a c channel we used ¾ inch spacers with two inch screws and nuts. We put the screw through the c channel -> ¾ inch spacer -> high strength gear -> nut. The spacer was used to prevent the high strength gear from rubbing on the c channel. We then repeated the process for three more holes on ne gear for a total of four screws, spacers, and nuts. We repeated the process for the second wheel on another c channel.

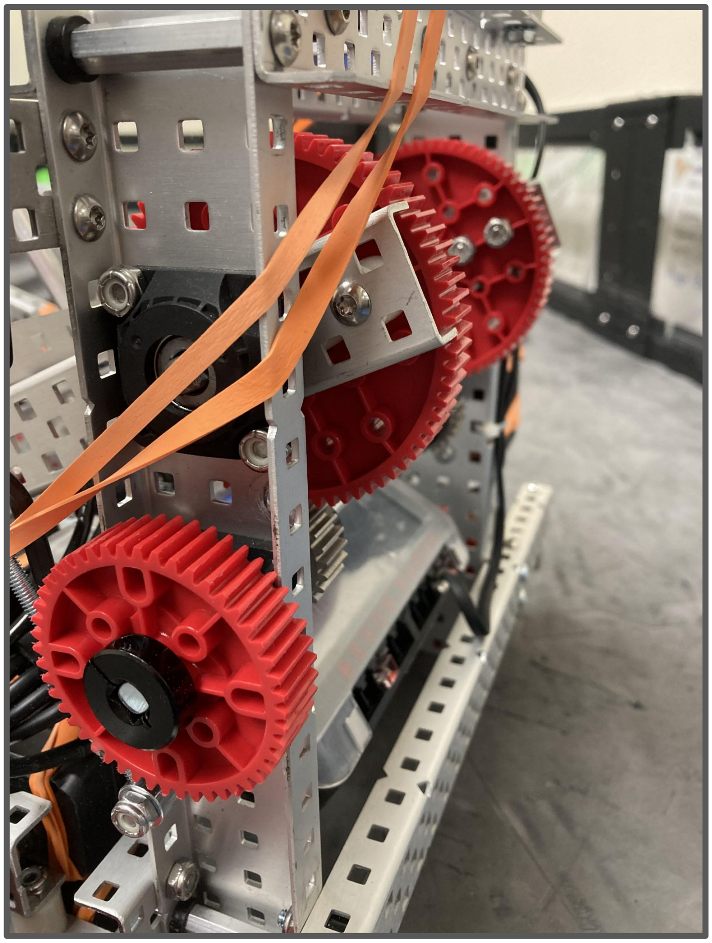
Catapult Design





To attach the two c channels together we use shafts. We used one five inch on the bottom since we ran out of one inch standoffs. We then attached another c channel horizontally across the top of the two parallel c channels to make an upside down u shape. This helps our catapult be more stable and resist the force applied when a tri ball is launched. To attach the c channel we used two sets of ¼ inch screws and nylock nuts. We used two on each side. The c channel was placed upwards to try and hold a tri ball better.

Catapult Design



The next step was mounting our catapult. To do so, we began by attached two c channel perpendicular to our drive train. We made sure there was enough space to comfortably access the brain and to easily remove the cover. We used two screws and nylocks in three vertical holes, leaving the middle hole empty. In the middle hole we used a one inch shaft with small black spacers. We sandwiched another c channel parallel to our drive train for stability and strength. To attach the u shaped piece of the catapult we made on the previous page we put the high strength shaft through either side of the c channels using a high strength ball bearing kit. The kit is designed to achieve a lower rotational friction through the use of rolling balls that are built into the bearing which are good for high speed mechanisms, such as catapults.To secure it, we used two ¼ inch screws with keps nuts diagonally on both sides of the c channels. Below it we attached another high strength shaft in the same way and put a high strength gear with a shaft collar on either side. One the second high strength shaft, we placed two gears that had a ¼ shaved down. ¼ of the gear being shaved would allow our catapult to fire and get back to position in time to quickly fire another tri ball. Once i was attached we used two more c channels on the top if the catapult, parallel to the ones on the bottom to secure the top. Similarly to how we attached the bottom, we used two screws with nylock nuts to secure it, along with a 1 inch standoff. We also placed 1 ½ inch standoffs between the two top c channels with black spacers so make the robot more stable. We then attached two washers to the far side o the top c channels and to the bottom of the catapult, and added two rubber bands to each.

Name: Brenna Rosario
Date: 10/08/23
Project Name: Catapult Design
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Catapult Design

We then tested our catapult on the field. We noticed that when we try to pick up and launch a tri ball, it slips out of place, making our catapult less effective.

Problem

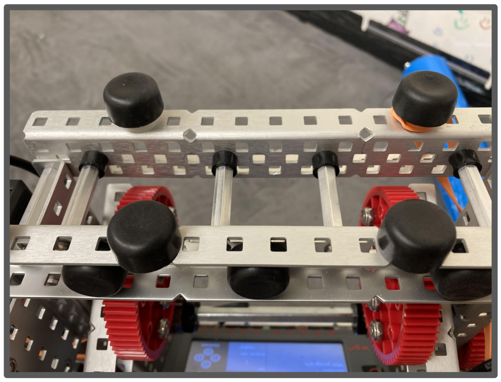
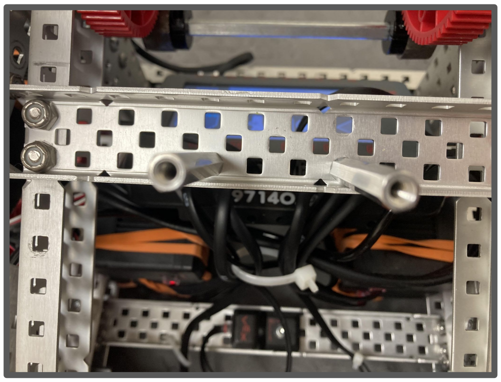
There isn't enough friction between the tri ball and catapult causing the ball to slip out of place.

Solution

To fix the issue of the tri ball constantly slipping out of place we had a few options:

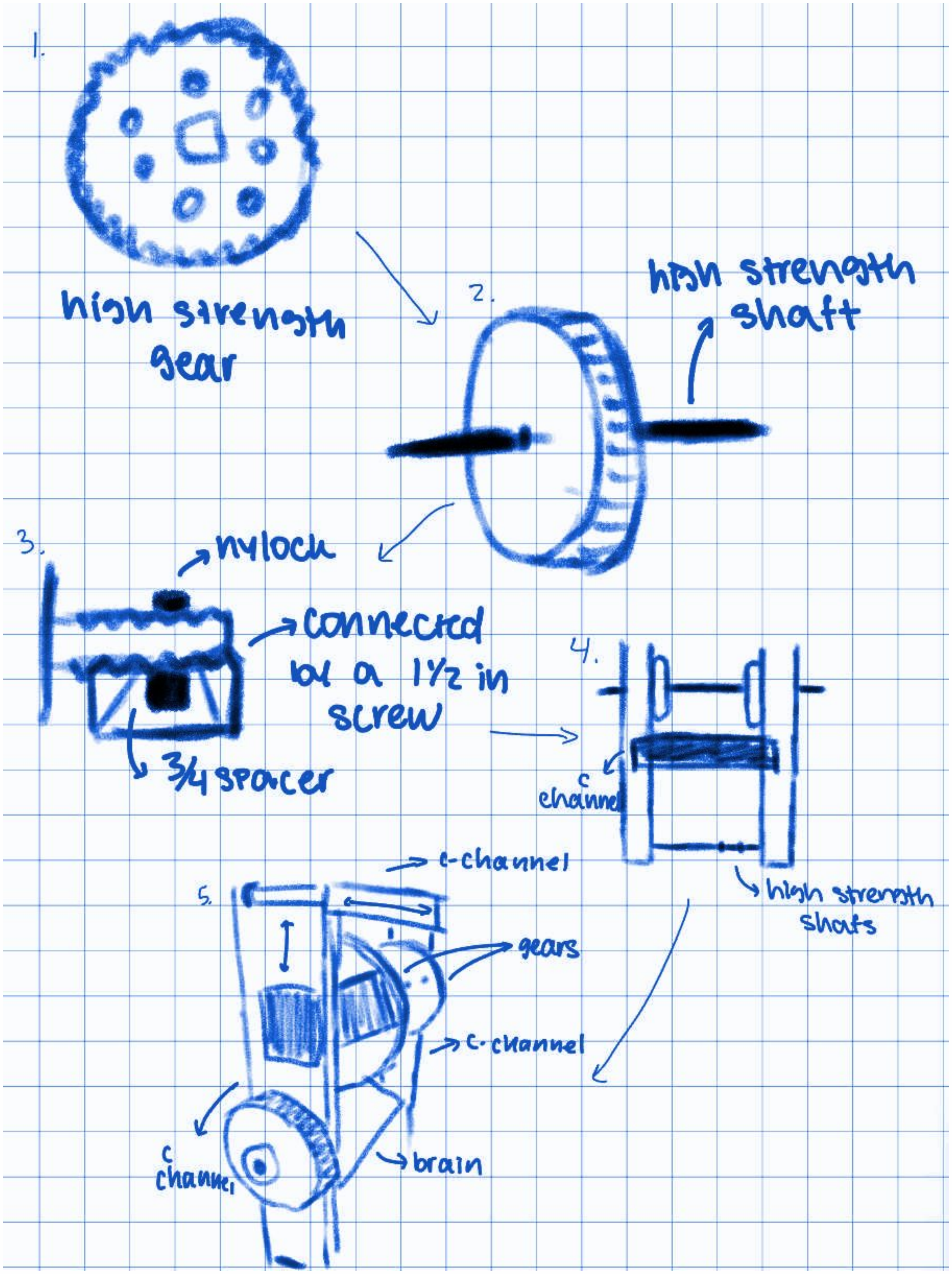
1. Attach arms or pegs to hold the ball in place
2. Attach stoppers to hold the tri ball
3. Rebuild catapult mechanism

We decided to combine the first two options, and decided to attach two sets of pegs/arms on different points on the robot, as well as stoppers on the top part of the c channels.

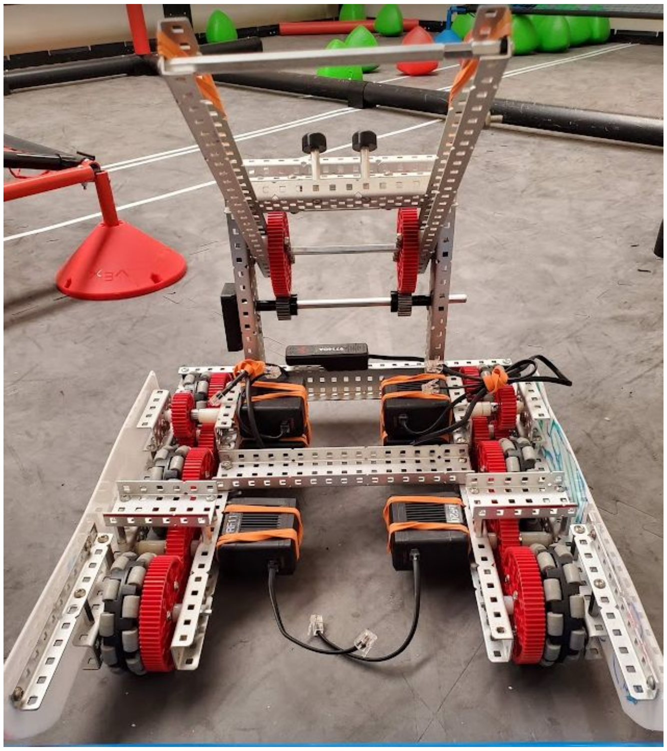



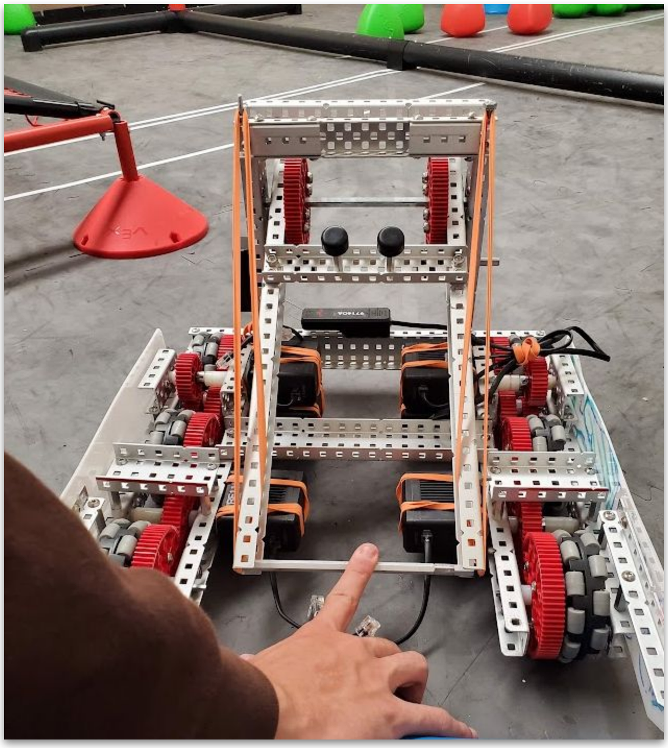

We used 7 door stoppers with two ¼ inch spacers attached with a nylock on the top part of our robot (picture on the left). We then tested it to see if it needed any more improvements. We noticed an improvement in holding the top of the tri ball but needed support toward the bottom so we added two 1 ½ inch standoffs attached with ½ inch screws on the c channel ⅓ of the way down the catapult. We attached two more standoffs that act as "arms" to further support the tri ball. We then tested our robot again and it worked well, so we moved on.

Catapult Design



Catapult Design





Intake Design

Today's Goals:

1. Intake design

Who was here:

- Matt
- John
- Lazaro
- Brenna

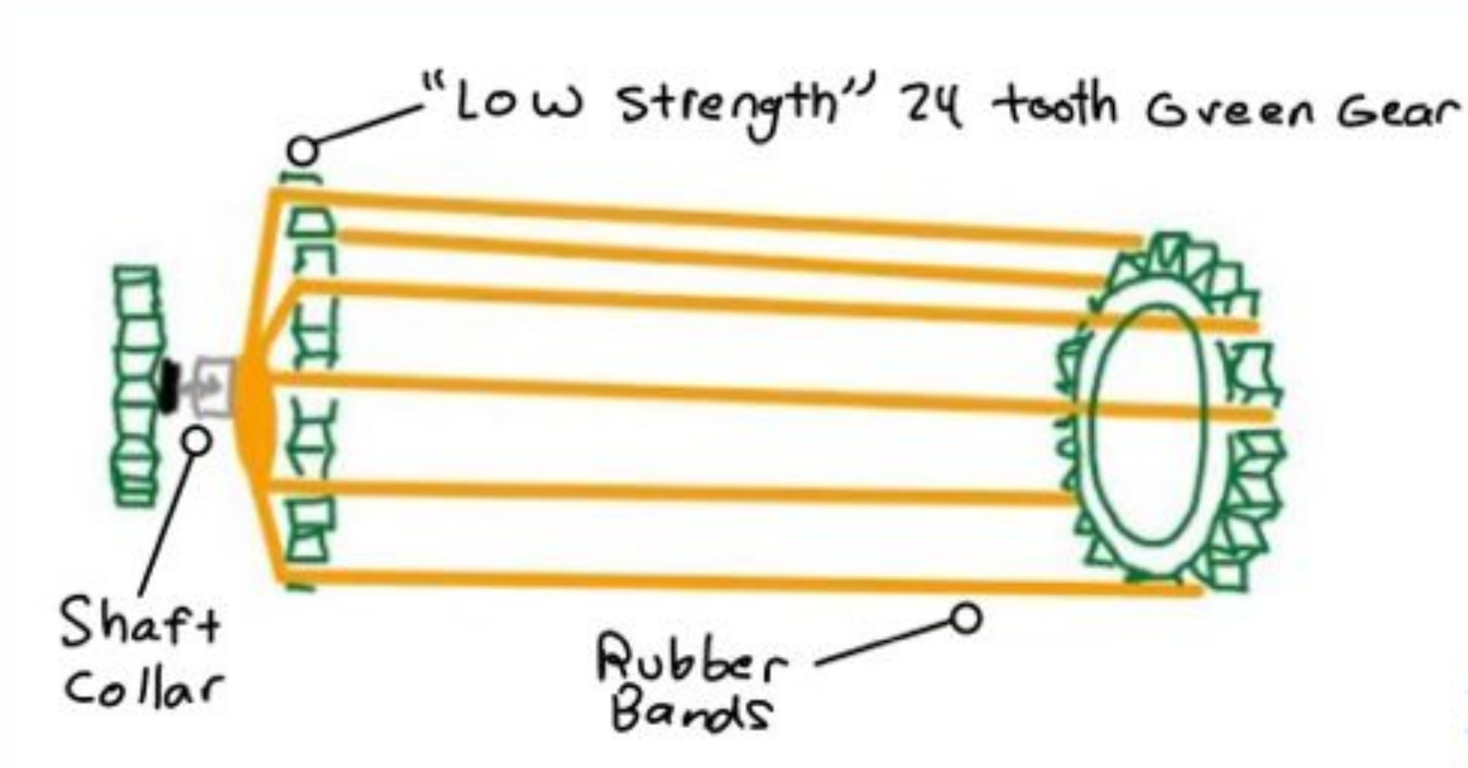
Time and date: 10/14/23, 10am-4pm

We finished the catapult and began prototyping our intake. We researched different intake options and compared and contrasted them. We also watched more game footage to observe patterns associated with each intake. We then wrote out the pros and cons of each and created a design matrix before choosing our final design.

Intake Design

We brainstormed ideas for the intake and have used some of the design options from the past.

INTAKE DESIGN POSSIBLE SOLUTION 1 - Rubber Band Rollers

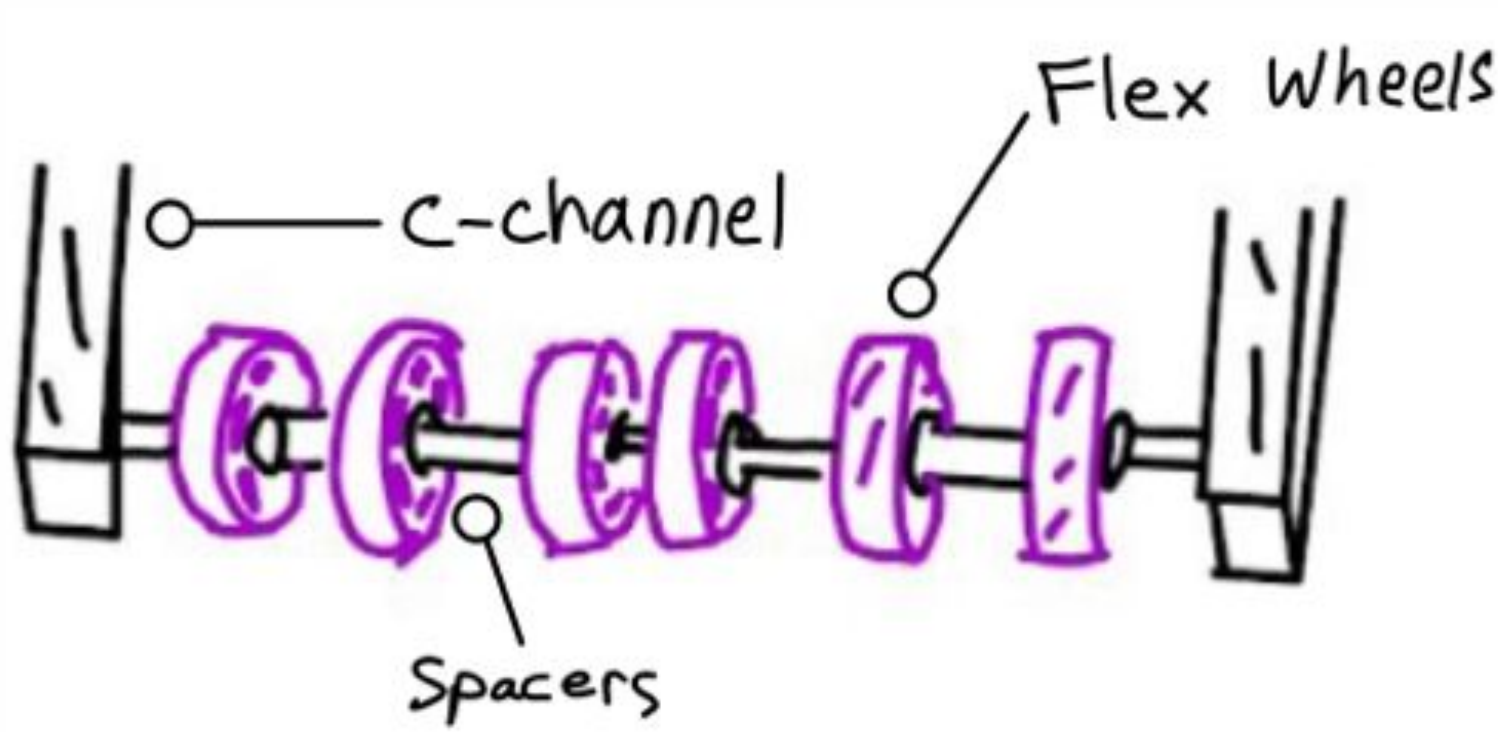


PROS - The rubber band rollers would be the most simple option, and we have used designs like this in the past so we would know exactly how to do it. Very light.

CONS - The rubber bands will need to be replaced all the time and will not always have enough force to pick up the tri balls. Bulky.

Intake Design

INTAKE DESIGN POSSIBLE SOLUTION 2 - Flex Wheels



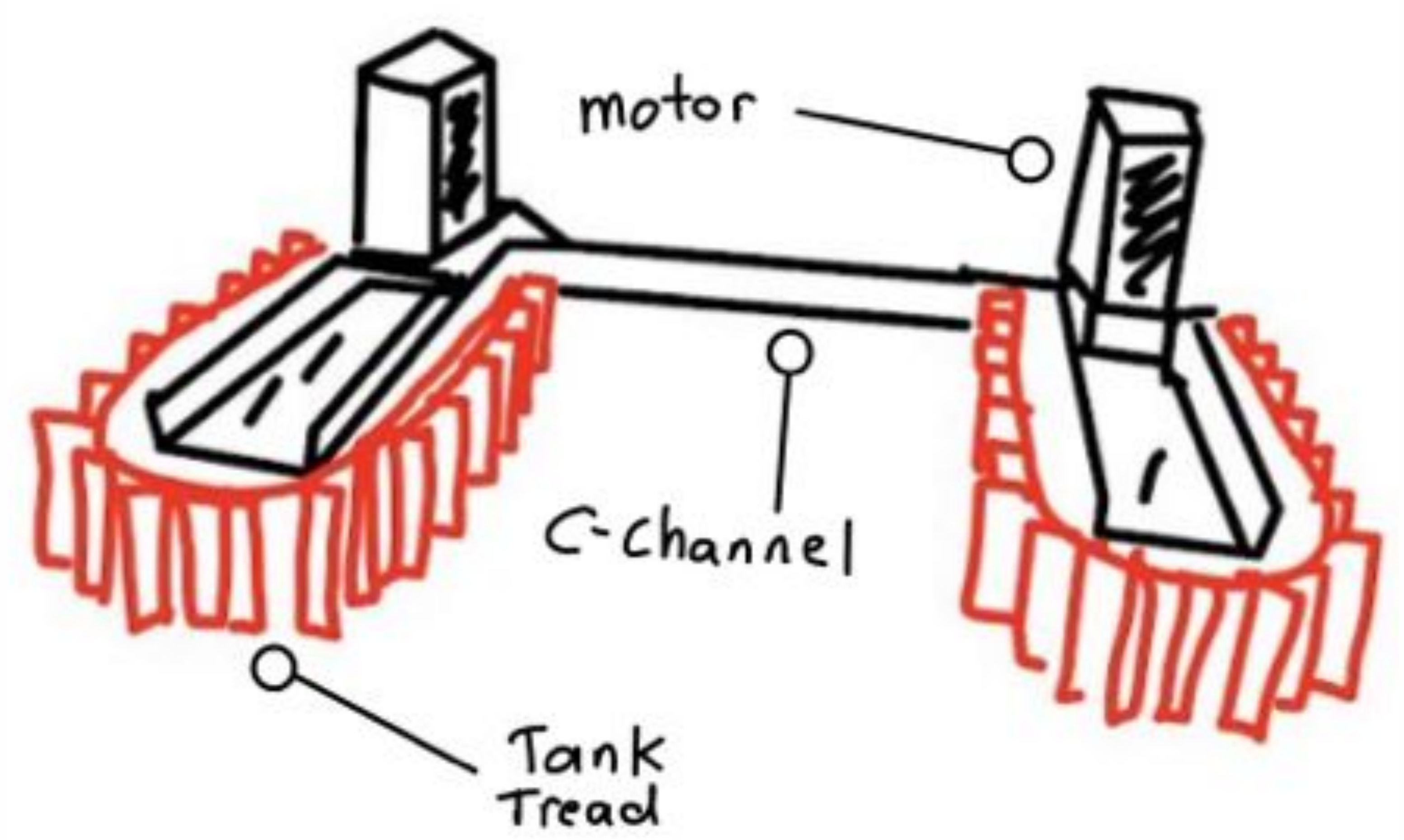
PROS - The new flex wheels have a lot of traction and come in many different sizes and strengths so there is a size for whatever space we need to put them in.

CONS - The flex wheels need to be positioned in many places to move

A tri ball. Heavy. Cumbersome mounting system not made for VRC shafts. Parts constantly out of stock.

Intake Design

INTAKE DESIGN POSSIBLE SOLUTION 3- Chain Flaps



PROS - The chain flaps can have a lot of reach towards the flex wheels since there are many different flap sizes. Can make very long conveyors. Easy to power.

CONS - The flaps have very little traction and the sprockets do not have the right sizes to fit perfectly onto the robot. Also the chain can always break which will lose us the game in some cases.

Intake Design:

Considerations

Reliability

- An intake must be reliable, as picking up and scoring game elements is the primary method to gain points in all VEX games.
- Intakes have many moving parts and are susceptible to breaking, especially at high RPM. Thus, the intake material must be durable to withstand long periods of operation.
- Intakes often stick outside of the robot frame perimeter. In this case, durability becomes extremely important; the intake must be built so that they can withstand impacts/collisions with other robots or parts of the field.
  There are two ways to accomplish this - either by building the intake very robustly (lots of support so it doesn't break), or making the intake flexible (for example out of lexan) so that even though it may bend due to impacts, it will always spring back into place.
  Another way to prevent intake breaking is to make a fully retractable intake that won't protrude outside the 18" cube, though this is seldom needed.

Consistency

- The intake must be able to pick up game elements consistently and quickly. For example, in spin up a robot could only pick up three pieces at a time. For over under it should be able to pick up one tri ball quickly, launch it, and pick up another.
- Another component is the varying angles that the game objects can be located in. This was especially apparent in this game with the tri balls being oddly shaped.

Source: gm0.org

Intake Design:

Considerations

Controllability

- The intake must be able to consistently control the game elements. For example, if the intake is too fast and the collection box is not well designed, then game pieces might fly out. If the intake is too slow, it may jam itself when contacting the game elements.
- It is possible for pieces to get jammed at an unreachable angle, especially when using wheeled intakes. If this occurs, ensure that the driver can jar the stuck element loose to avoid having a disabled robot.
- Optimally, the game elements should follow a certain path each time if funneling is done correctly.
- It is best practice that the driver can see the game elements which are being controlled. This can be done through using clear plating such as Lexan.

Efficiency

- The key to any successful robot is cycle time. Reducing cycle time by having an efficient intake will lead to major improvements in score. A good intake should take no more than a few seconds to successfully collect the needed elements.
  For example, in watching signature event matches we noticed that the best intakes often had a < 3 second collection time for a tri ball, and that some even had a < 1 second intake.
- A key rule to remember in any competition is the shortest distance rule: how can you get scoring elements from A to B in the shortest distance? We can shoot from anywhere on the field, but shooting the shortest distance is quicker and therefore better. The answer is usually one straight line that begins close to match loads. The closer the scoring elements follow this path, the faster they will go from collection to deposit. We try not to make long routes between the match load spot n=and the shooting location to make our robot more efficient.

Source: gm0.org

Intake Design

Since the rubber band roller design had the most total points, we decided to use the design. We began by looking at one of our older robots that had used a rubber band roller design to prototype. We also looked back on the pros and cons.

Pros- The rubber band rollers would be the most simple option, and we have used designs like this in the past so we would know exactly how to do it. Light design would not greatly affect the maneuverability and ease of driving of the robot.

Cons- The rubber bands will need to be replaced all the time: We can easily replace the rubber bands for cheap. We can also use stronger and more durable rubber bands. Bulky: We can use smaller high strength gears and fewer rubber bands and adjust as necessary. Tri balls too heavy to be picked up: we tested an realized this was not true because the tri balls are light.

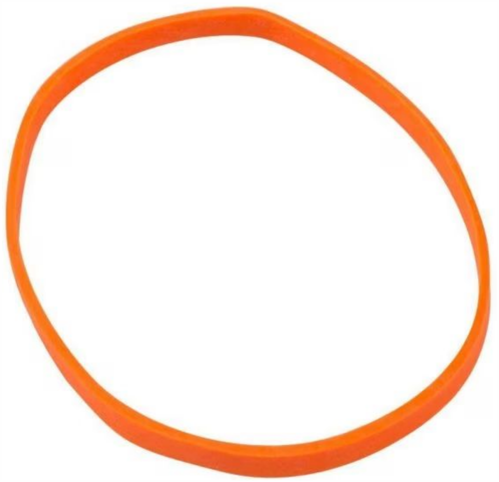
Decision Matrix

	Rubber band rollers	Flex wheels	Chain flaps
Durability	3	3	3
Ease of design	5	4	4
Maintenance	4	5	2
Force	5	3	3
Stress	4	3	4
Power	5	3	3
Total	26	21	19

Name: Brenna Rosario
Date: 10/14/23
Project Name: intake Design
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Intake Design

The following are parts we plan on using in our intake:



VEX Rubber Bands have dozens of uses on a robot. Their spring-like properties make them perfect for latches, triggers, and return mechanisms. EPDM Rubber Bands and Synthetic Rubber Bands work better for high elongation uses, while Silicone Rubber Bands have a higher coefficient of friction against many types of plastic, enabling your intake mechanisms to grip objects easier.

We use regular VEX gears rather than high strength one because they simply aren't necessary. We plan on using the largest size, 84T. To create the actual intake, we are going to wrap rubber bands across each of the gears. The rubber bands will allow us to grip onto the tri balls easier, which is particularly useful due to their slippery surface and odd shape.

Open House

Today's Goals:

1. Talk to prospective kennedy families and have fun!
2. Go over competition schedule
3. Review Budget

Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 10/15/23, 12pm-4pm

We began by going over the competition schedule for the rest of the year. Next we cleaned up and set up the room for the open house. We took out all of our robots out, and displayed all of our robots. Parents and students began arriving around 1 pm.

When parents and students arrived we gave them an overview of the program, and how VEX competitions and seasons work. We had a few interested people that will hopefully join us next year!

Open House:

Team Tournament Schedule

Since we had some time before parents and students began arriving, we spoke about our schedule for the rest of the year. We will continue meeting on Saturday and Sundays until competitions start. Our competition schedule is as follows:

- WAVE at WPI VRC Signature Event (MAYBE - Not Confirmed)

  Date: 30-Nov-2023 - 2-Dec-2023

  Location: Worcester Polytechnic Institute, Worcester, MA

- Mount Academy VRC Over Under Qualifier (Confirmed)

  Date: 9-Dec-2023

  Location: 1001 Broadway, Esopus, New York, 12429

- Farmingdale Qualifier (Confirmed for 2 Kennedy teams. Only allows 2 teams per organization for this tourney. TBD which two teams.)

  Date: 7-Jan-2024 SUNDAY

  Location: 150 Lincoln Street, Farmingdale, New York, 11735, United States

- Fallsburg Qualifier (MAYBE - Not Confirmed)

  Date: 13-Jan-2024

  Location: 115 Brickman Road, FALLSBURG, New York, 12733, United States

- Wildcats VRC Over Under Qualifier @ RCDS (Confirmed)

  Date: 20-Jan-2024

  Location: Rye Country Day, 3 Cedar Street, Rye, New York, 10580

Open House:

Team Tournament Schedule

- Bellmore Kennedy HS (Confirmed for 2 Kennedy teams. Only allows 2 teams per organization for this tourney. TBD which two teams.)

  Date: 27-Jan-2024

  Location: 3000 Bellmore Avenue, Bellmore, New York, 11710, United States

- VCAT VRC Tournament at Vaughn College (Confirmed)

  Date: 4-Feb-2024 SUNDAY

  Location: 86-01 23rd Avenue, Queens, New York, 11369, United States

- Kennedy Gaels Clash @ Kennedy (Confirmed)

  Date: 10-Feb-2024

  Location: Kennedy Catholic Preparatory School, Somers, New York 10589

- Adelphi University Over-Under Qualifier (Confirmed)

  Date: 17-Feb-2024

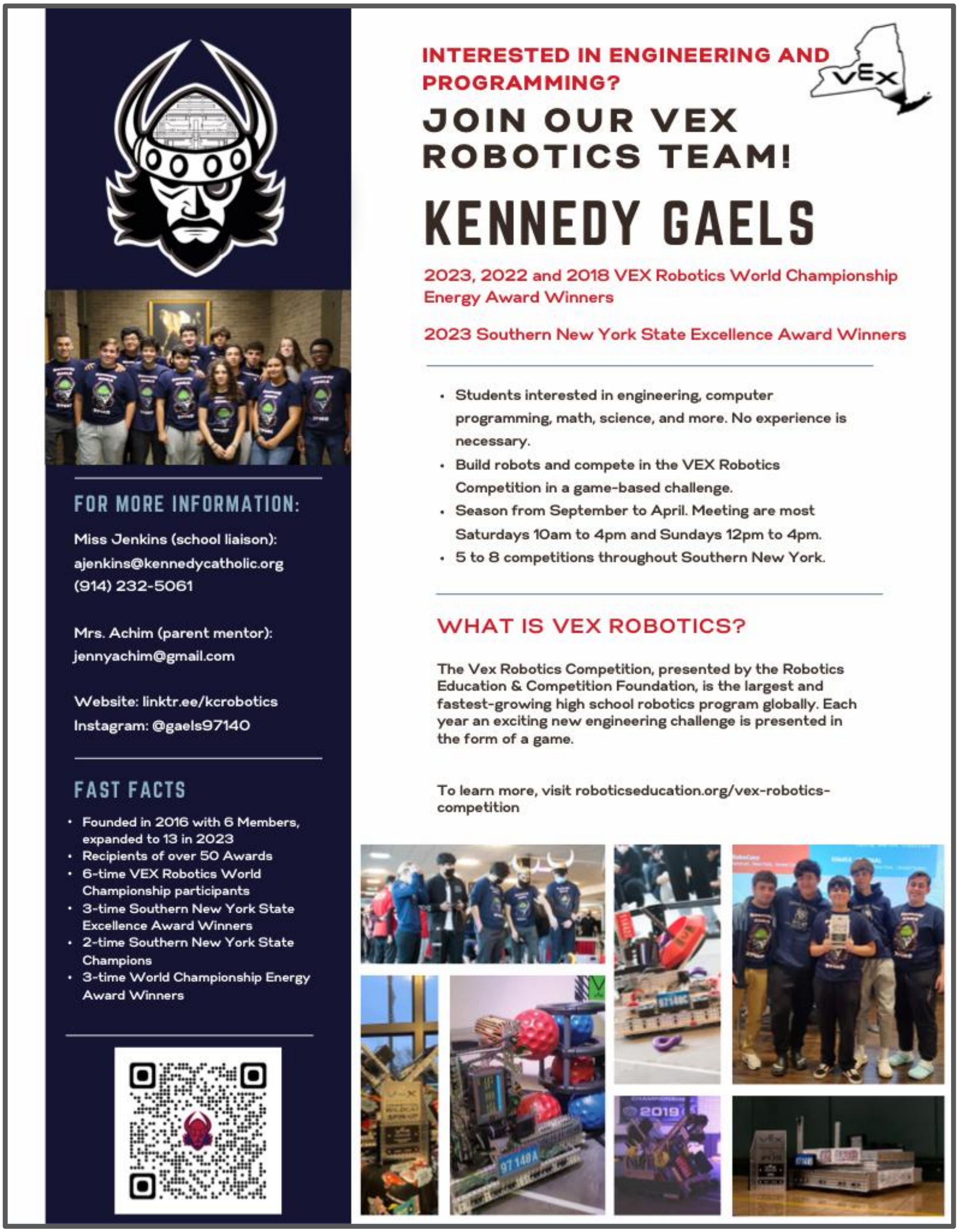
  Location: 1 South Avenue, Garden City, New York, 11530

Open House

Robotics Room With Awards and Robots from Previous Seasons Display

Open House

Flyer



Testing and Troubleshooting Robot

Today's Goals:

1. Prototype intake
2. Testing and troubleshooting
3. Fix loose parts

Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 10/21/23, 10am-4pm

We drove the robot and tested it to see what is working well and what is not. We began by adding shaft collars to the motors, tightening screws, and bracing the bottom of the catapult.

We also began prototyping our intake based on the decision matrix and design considerations from the last meeting.

Testing and Troubleshooting Robot

Problem: The high strength shaft in the motor continually comes out or loosens.

Solution: Add shaft collars which are discussed below.

High Strength Shaft Collars are designed to fit onto High Strength Shafts. This clamping-style collar uses standard hex and star drive screws and nuts to maintain a tight lock without scratching or damaging the shaft.

- Designed specifically for VEX 0.25" High Strength Shafts
- Standard VEX screws use a 3/32" allen key
- Clamping collar is easily adjustable without damaging shaft

Testing and Troubleshooting Robot

Problem: Loose and shifting parts on the top of the catapult.

Solution: Tighten and add more screws. Use different screws and nuts.

We chose to use nylock nuts because although they are heavier, they tend to grip better so we frequently use them on wobbly parts of the robots like the catapult. Nylock nuts have an internal nylon lock that makes them perfect for strong, permanent connections.

We also chose to use locking screws because they have a thread locker coating that keeps them locked in place. They can be installed 10-15 times without losing their grip.

Testing and Troubleshooting Robot

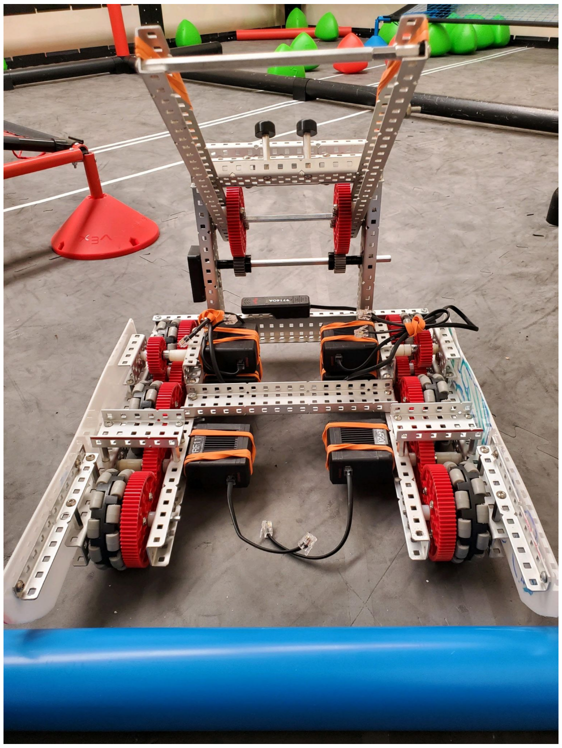
Problem: Wobbly motor.

Solution: Tighten the motor screws. Also, use rubber bands to ensure that the motors and covers are held in place.

Problem: Bracing is weak. Odd placement.

Solution: We changed the top brace to a bottom brace so that it was in an easier position. We also used locking screws and nylocks to ensure that the bracing stays stable.

For the rest of the meeting we discussed load resistant intakes and prototyping one. Although we did not fully complete an intake design we started bracing for it in anticipation. We added two small pieces of c- channels to the front of our robot and supported them with nylocks and locking screws.



Building Intake

Today's Goals:

1. Build intake!

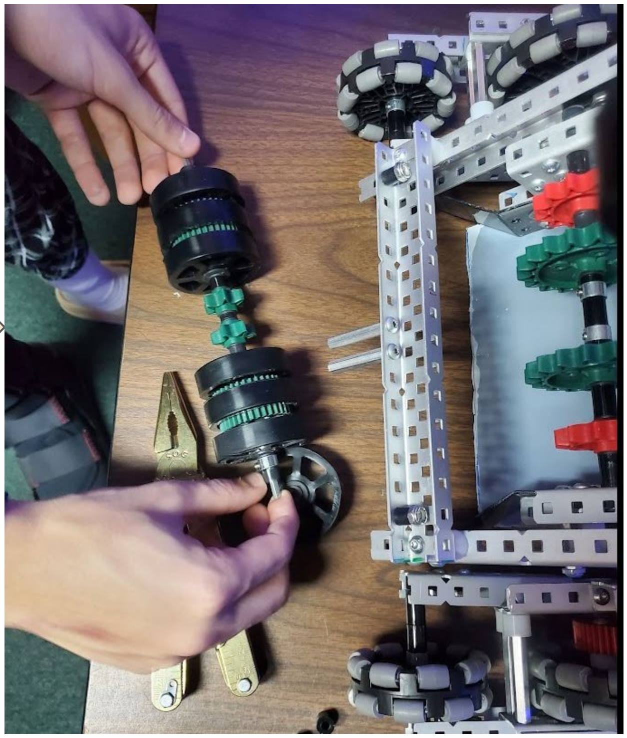
Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 10/22/23, 12pm-4pm

We began finalizing our intake design. We then began building because we didn't want to waste any time.

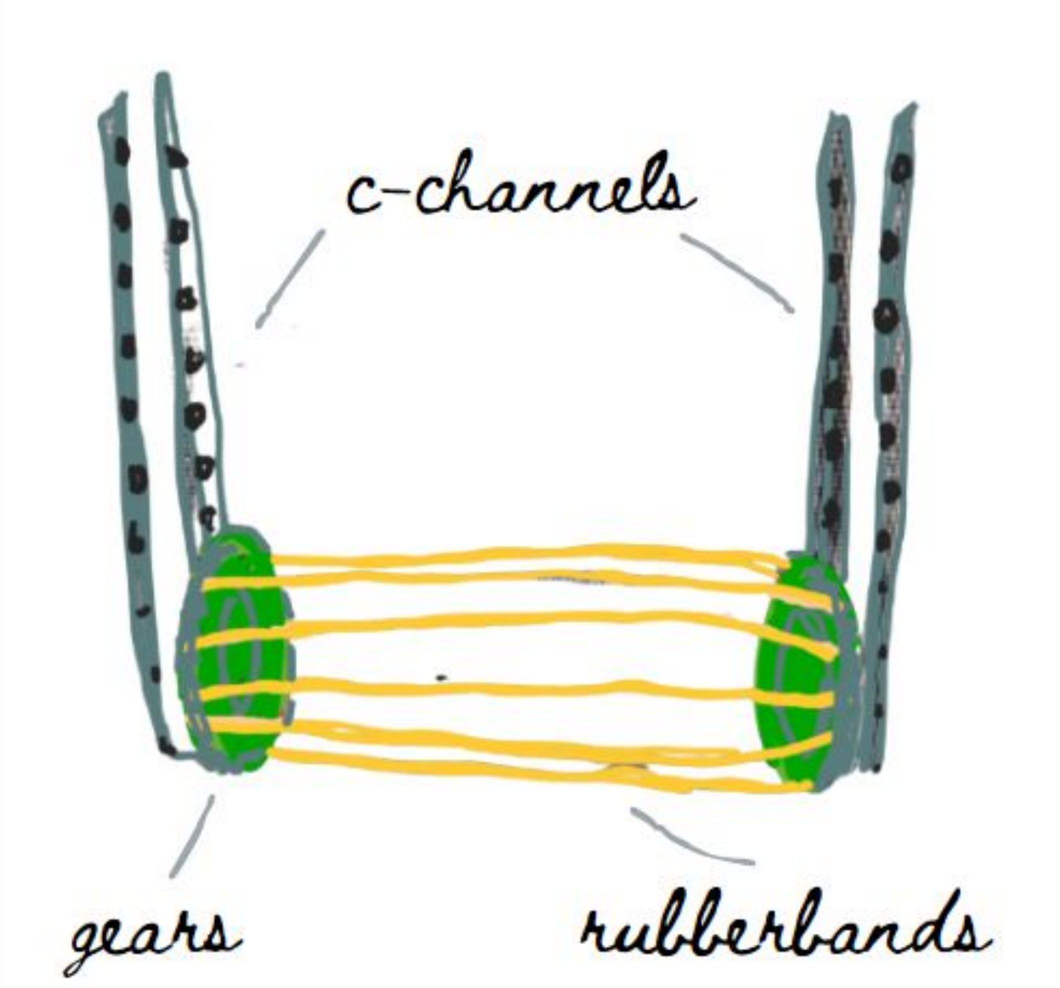
Intake Design from our Spin Up 2022-2023 Season



Building Intake:

Iterated Design

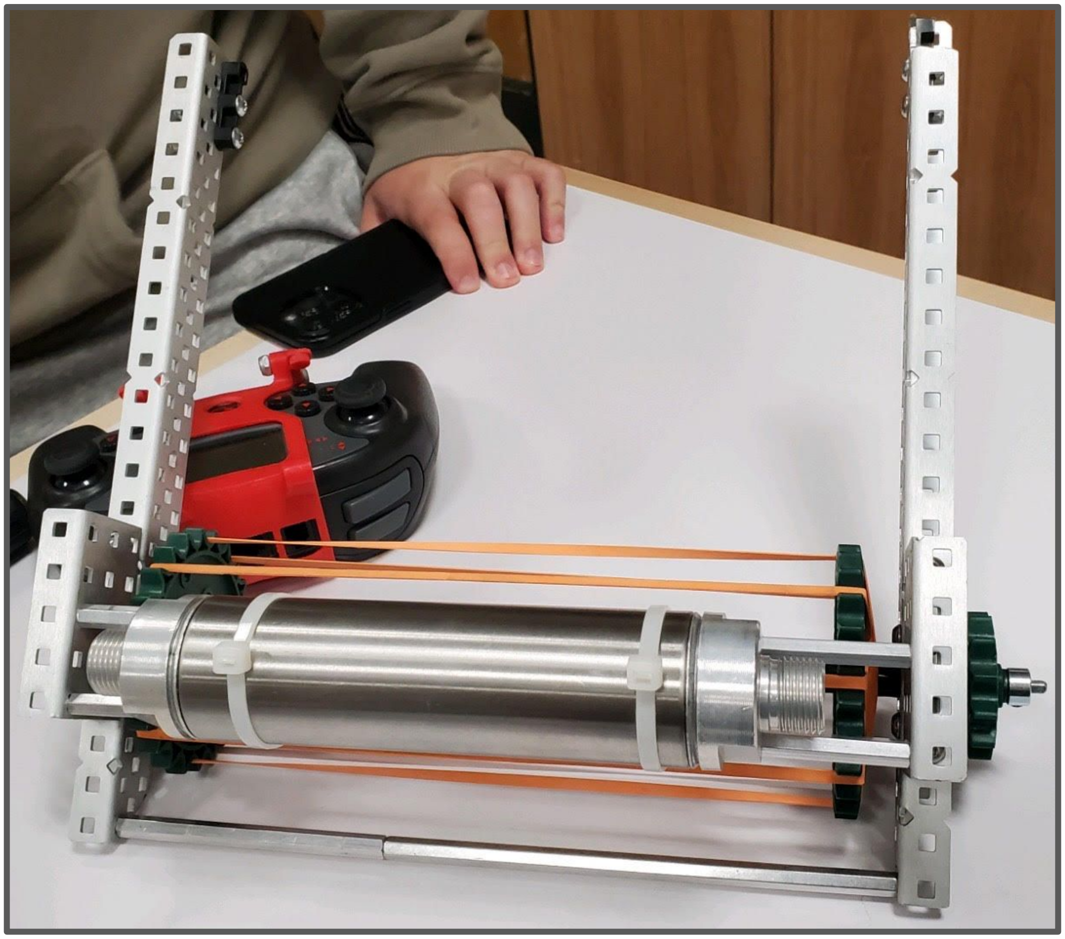
Our final intake design consists of two gears bound together with a shaft and wrapped with rubber bands sandwiched between two parallel c- channels. We plan on using two regular (green) gears. We will connect them with strong rubber bands to overcome need for replacement in the future. The shaft that goes through the two gears is reinforced with ½ inch black spacers. It will be powered by pneumatics.

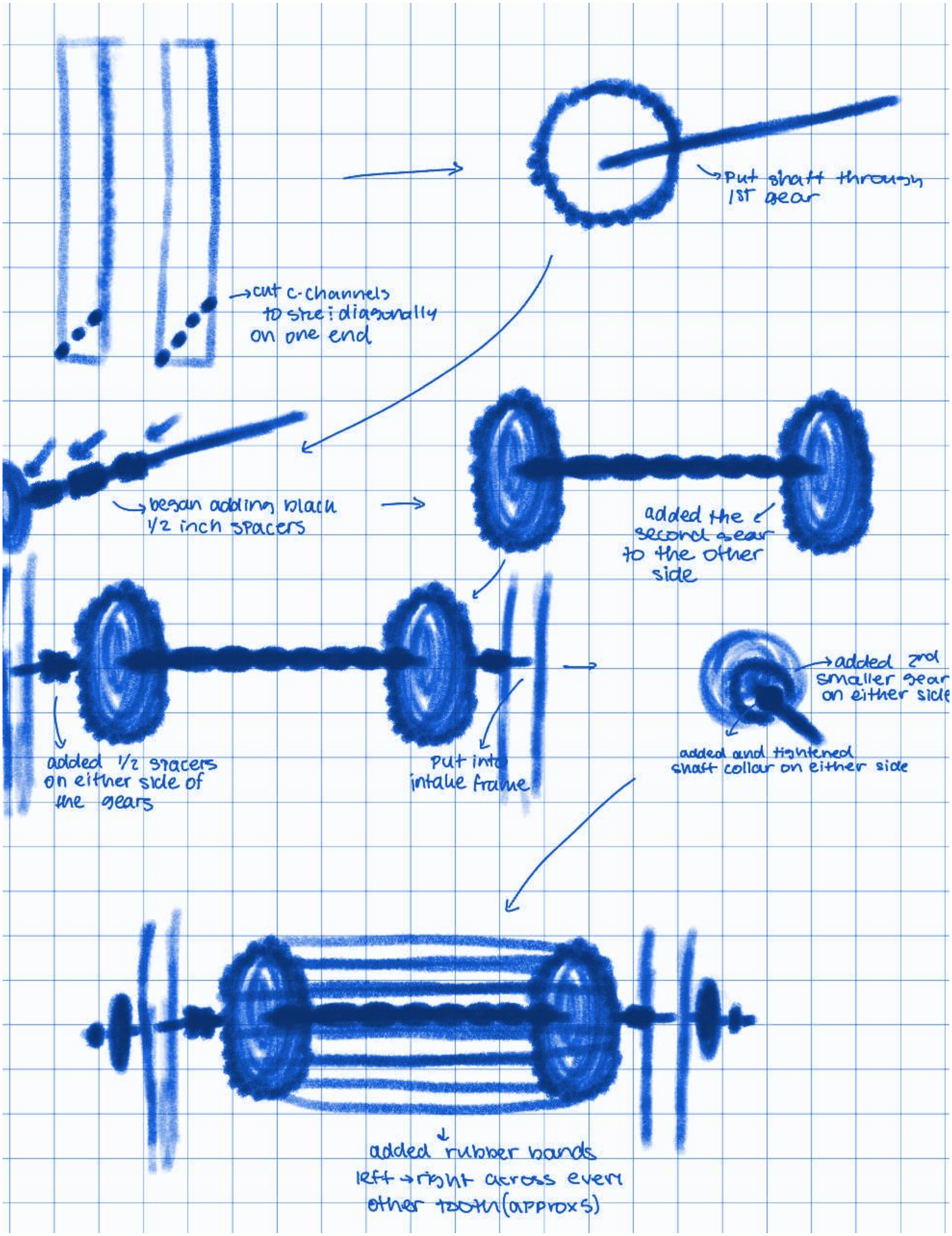


Building Intake:

Iterated Design

To build the intake, we started with two c- channel that we cut down to size and diagonally at one end. We then took a shaft and also cut it down to size. To reinforce it, we pushed ½ inch black spacers onto it. We then secured the shaft between the two green gears by using smaller green gears and regular shaft collars on each side. We put another black ½ inch spacer between the larger gear and the c-channel. We then used rubber bands on every other tooth in the larger gear and stretched them horizontally between the two. We then attached standoffs to the front of the catapult (where the c-channels were cut diagonally) using ½ inch screws.The pneumatics mounting will be discussed on another page.





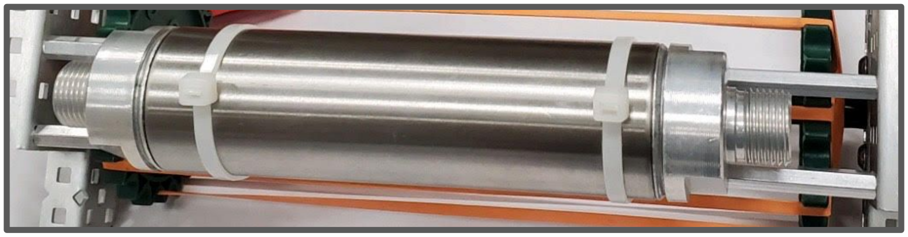
Name: Brenna Rosario
Date: 10/22/23
Project Name: Building Intake
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Building Intake

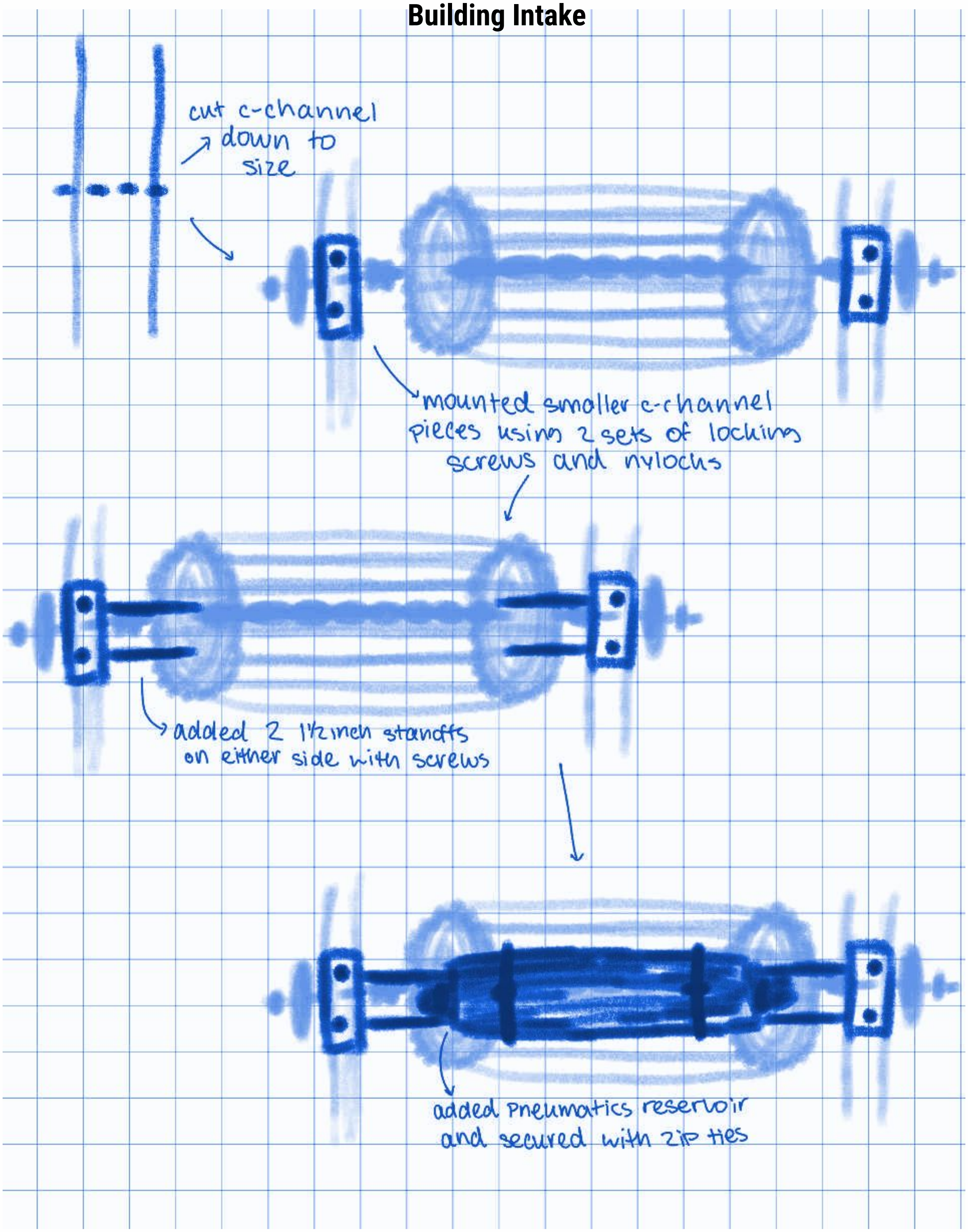
To mount the pneumatics reservoir, we first added two smaller pieces of c- channel that we cut down to size. We help the reservoir in place to estimate how much space we would need, and decided to mount the smaller pieces to the frame of the catapult. We used locking screws and nylocks (2 sets per side) because we know that the catapult moves a lot, and wanted to make sure that nothing would come loose.

We then estimated the amount of space between the reservoir and the sides, and guessed one inch. We tried mounting the 1 inch standoffs, but they were too small, leaving us with two options: 1) use 1 ½ inch standoffs, 2) use the 1 inch standoffs with ½ inch spacers. We decided to use the first options, and the standoffs fit perfectly. We mounted them using ½ inch screws.

We then secured the cylinder with two white zip ties. We realized when tightening them that they added extra height to our robot, meaning it could be out of size and we would fail our inspection. We precisely cut them down to size and moved on to mounting the catapult to our robot.



Building Intake

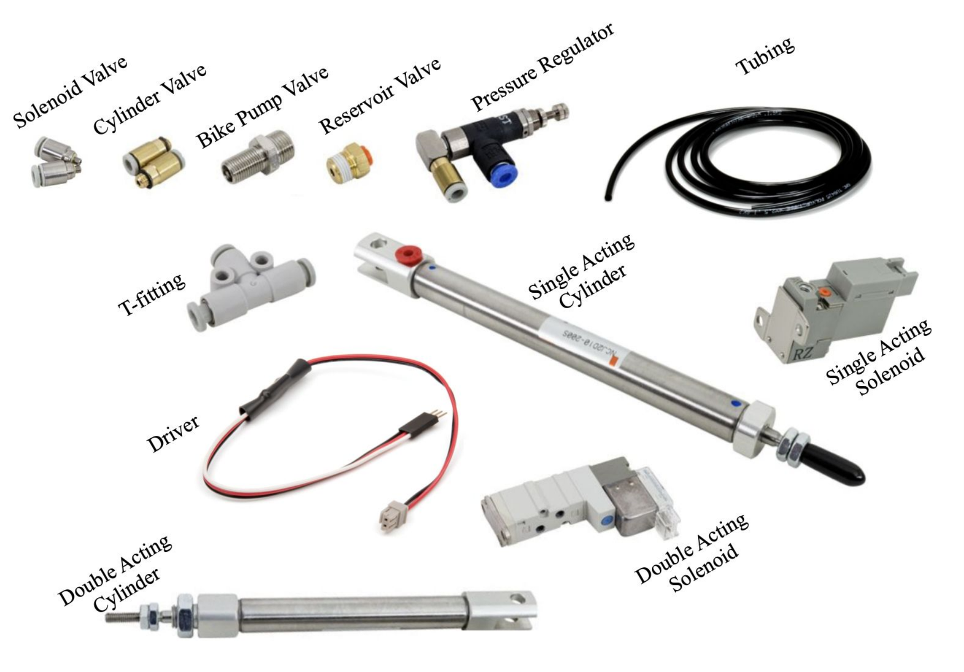


Name: Brenna Rosario
Date: 10/22/23
Project Name: Building Intake
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Building Intake:

Pneumatics

Pneumatics are a system of components that use compressed air to create motion. In most cases, this is linear motion from cylinders (sometimes called pistons) but this motion can be used in many different ways. In your life, think about pumps for athletic balls, nail guns, and shocks on bikes. There are 3 subsystems to pneumatics in Vex. There is Air Storage, Air Control, and Pneumatic Cylinders.



Air Storage is where the pressurized air is held in a robot. For Vex, this is done in aluminum reservoirs. In most seasons, a team can have 2 of these on their robots and they are pressurized to a maximum of 100 psi (Pounds per Square Inch). The 2 main considerations in storage are the volume and the pressure of the air. The volume changes how many times that you can fire the cylinders and the pressure changes how strongly the cylinders fire.

Building Intake:

Pneumatics

Air Control defines when and how actions are taken with pneumatics such as cylinders. In pneumatics, this is done with either Finger Valves or solenoids. A Finger Valve is a manual 'on and off' switch for cylinders and pneumatics. Solenoids are used for actuation as they plug into the V5 brain and control the flow of air through the system (and can be programmed). This is the main way that teams will interact with pneumatics on the robot through programming (see Pros guide for more). The Pressure Regulator is used to control the pressure released from the reservoir to the solenoids. Placed near the reservoir in the system, the pressure can be increased or decreased as needed.

Pneumatic cylinders are the third subsystem of pneumatics and are where the motion comes from. In Vex, there are both single, and double-acting cylinders. Single-acting cylinders are powered outwards and then released with no force in the other direction. Double-acting cylinders on the other hand are powered in both directions with the same amount of force. The two do have different types of solenoids though.

Components

Pneumatics consist of seven major components:

Tubing - Physical carrier for the pressurized air.

Reservoir -Storage for the pressurized air.

Pressure Regulators -Valve to regulate the pressure of air in the system.

Finger Valve/Flow Switch -Simple on/off switch for airflow.

Solenoids - Control components that turn electrical signals into commands for pressurizing the system. Connected to both V5 Brain(requires drivers) and Pneumatic tubing for control.

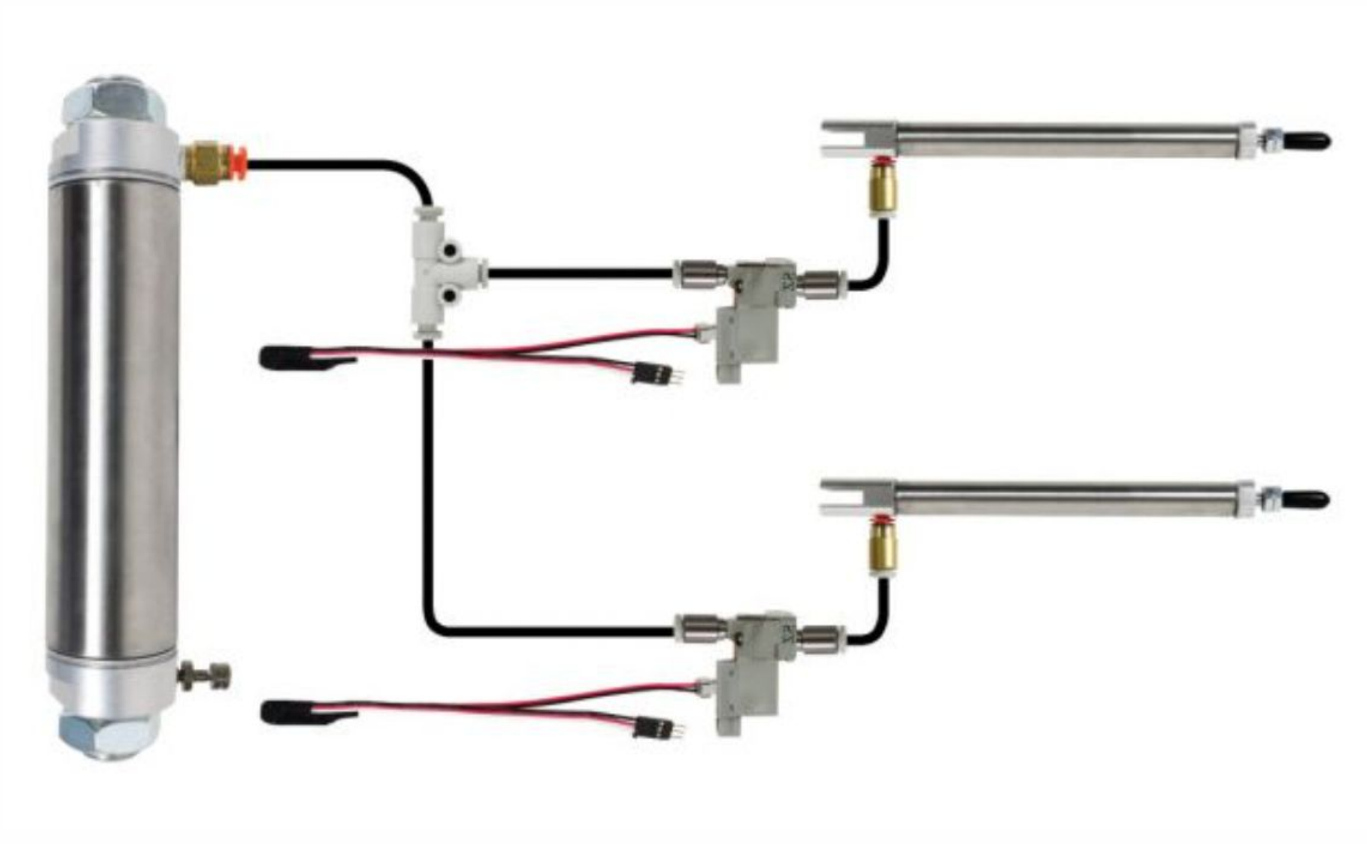
Reservoir Valve -Used for attaching tubing to reservoir

Solenoid Valve - Used for attaching tubing to solenoids

Cylinder Valve -Used for attaching tubing to Cylinder

Building Intake:

Pneumatics



Above is an ideal system. At the bottom of the reservoir is the bike pump fitting to refill and pressurize the reservoir. The top is the valve for tubing where a pressure regulator could also be installed. Following the tubing is a T-fitting which is used to move air around the system and robot. Following the fitting are the solenoids (with 2 more valves on each) and the drivers (the wires extending out) followed finally by the solenoids.

Building Intake:

Pneumatics

When using pneumatics, there are many things to keep in mind for optimal performance. These range from the design process to actually in operation.

Design

- Leave spacing for Solenoids.
    - The solenoids which control the pistons are small, but make sure that you leave ample space around the connectors for tubing so the connectors fit well.
- Do not design tight corners for Tubing.
    - There is a high risk that your connections will be ripped out if you run the tubing around sharp corners, tubing and solenoids can both get damaged. There is also a chance that the tubes could be kinked and stop or limit airflow
- Consider weight distribution of Reservoirs
    - The reservoirs may be aluminum but are still fairly large and heavy. It is beneficial to keep these low and centered on your robot. It is also important to keep room for these components as they do take up a lot of space.

Construction

During robot construction, there are not many helpful tips, but these should always be followed.

- Always overuse Tubing.
    - There is never a downside to using too much pneumatic tubing. Using too little can lead to connections being damaged and tubes being stretched. Having slack in tubing lines is important to ensure consistent operation.
- Know your pivot points.
    - The majority of applications for pneumatics have linear motion being converted to some rotational motion. Make sure to solidify whichever point you have that pivots.

Gear Box

Today's Goals:

1. Gear wall box remake

Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 11/11/23, 12pm-4pm

We finalized the gear box for the intake system and are going to test it.

To finalize the gear box, we began by taking off all of the built up c- channels and combining as many as possible. We did this because the many built up pieces became flimsy and bendable. They became a lot more solid when we combined them into different pieces.

We also had a few problems with loose screws that we had to fix. We left some keps nuts around the robot looser than we should have. To fix them, we replaced them with lock nuts.

Building Intake:

Pneumatics

- Distribute the Loads.
  - Be certain to even out the force on each side of the pneumatic cylinder. If only one side is loaded, there is a high chance the pneumatics will not function as intended.
- Never work on pressurized pneumatics.
  - For safety, never work on pneumatics that has pressure, use the regulator and flow switch to depressurize or isolate workable components before doing any maintenance.
- Use Teflon tape.
  - Teflon tape is used to seal anywhere that there is a thread in the system. For all valves, Teflon tape helps to reduce the risk of leaks. If your system has leaks, the best place to look is at valves.

Operation

For ideal operation, follow these tips.

- Optimize the airflow into Tanks.
  - The pneumatics kits come with a regulator. Experiment with the amount of airflow through the regulator so that your pneumatics have just enough force to complete your intended action. This will mean the cylinders can actuate more times per full pressurization.
- Pressurize tanks at every opportunity.
  - The legal pressure is set at 100psi, which is quite low for most applications. Due to this, the constant re-pressurization of tanks must be a priority.

Solidify Intake and Catapult

Today's Goals:

1. Solidify Intake and Catapult

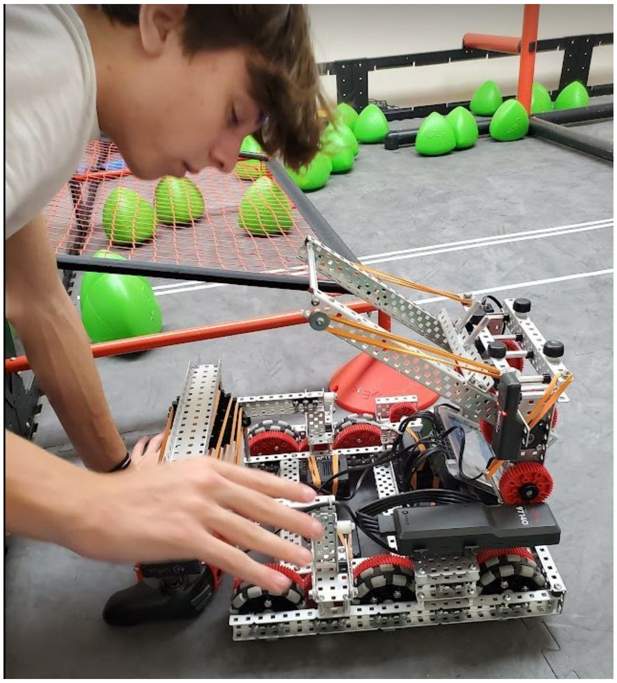
Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 10/28/23, 10am-4pm

Today we began by working on the intake. There wasn't enough space for the tri ball to go into the intake, meaning it was not working as effectively as we hoped.

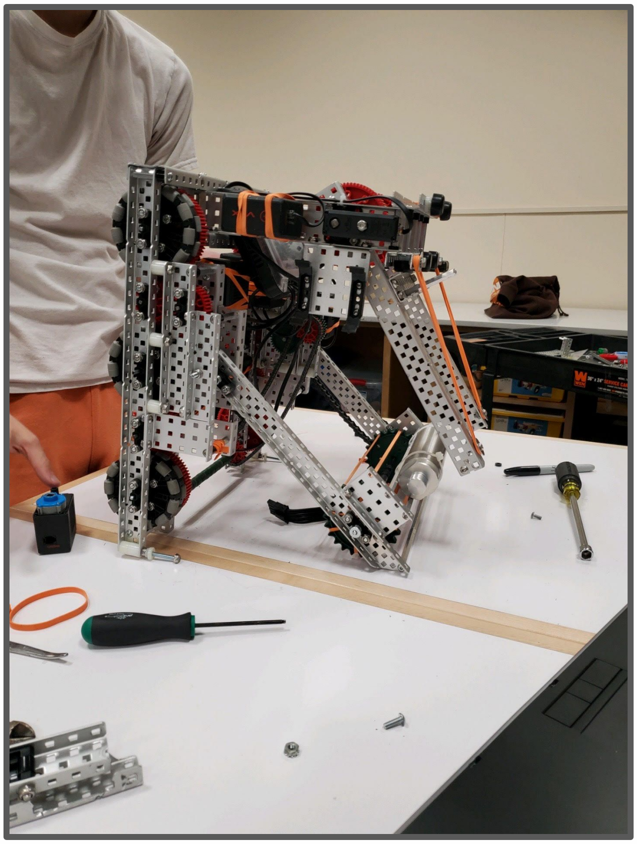
We also figured out one of the main errors in our catapult and fixed that. Everything we did is discussed on the next few pages.



Solidify Intake and Catapult

Problem: Intake is not allowing enough space for the tri ball to enter. Intake is ineffective.

Solution: To fix the intake, we changed the intake towers and added two holes to it. By raising the towers, there was more space for the tri ball to go through. We then tested the robot. Pictures during and after are below.

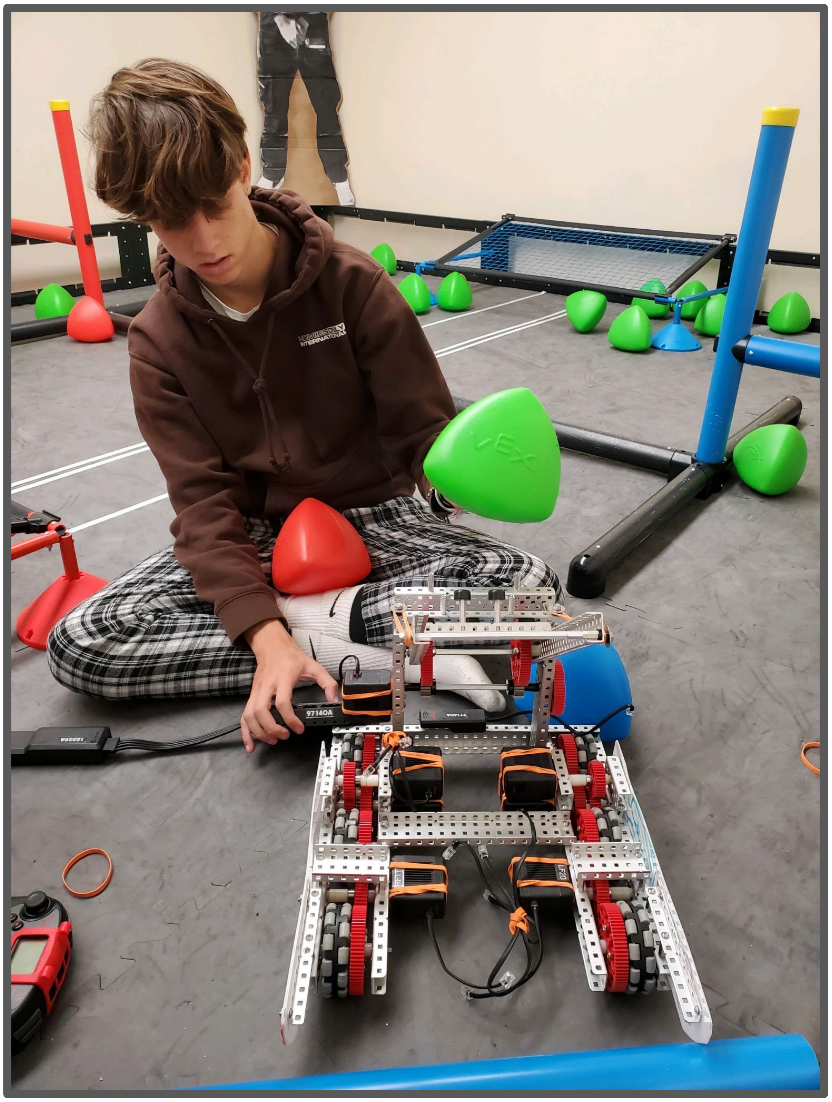


Name: Brenna Rosario
Date: 10/28/23
Project Name: Solidify Intake and Catapult
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Solidify Intake and Catapult

Problem: There is an error in our catapult. After further testing we realized that it was inconsistent.

Solution: We previously had the catapult set to 8 degrees, however it would show up as different numbers. Instead of having the code at con.button.pressing, we changed it to release so that instead of counting the press it would only count one release. Pictures of us testing the robot are below.



Solidify Intake and Catapult

<u>Problem:</u> The intake was not as effective as we hoped.

<u>Solution:</u>

We fully rebuilt the intake and decided to look at more footage. One robot design we liked in particular was ACE Robotics. We took inspiration from their intake, but completely rebuilt it in our own unique way, and in a way that we know would work best for our robot. We also took inspiration from a design we've used before. We took 2 long c-channels angled upwards and figured that it was the best way to build for a few reasons. The upward angle of the intake allows it to ride over the pole meaning the tri ball can more easily be shoved in. We also added a high strength shaft underneath so that the triball can be held in between the intake and the catapult. This makes it easier to hold the tri ball whenever we need to.

The high strength shaft and intake system are controlled by one motor, but they needed to spin in opposite directions. We built a gearbox to change the direction of it in a really tight space such as between the catapult and the side wall.

We also put a full motor instead of one of the smaller motors (half motor). We used more power instead of having to make a separate stick to take out the alliance triballs from the side goal. The new intake is pneumatized and can reach over the bar.

We are also figuring out a way to park by looking at other robots in signature events. Pistons stick out of the side of the robot to hold it into position.

Robot Testing and Adjustments

Today's Goals:

1. Fix inconsistencies
2. Make driving as smooth as possible

Who was here:

- Matt
- John
- Brenna

Time and date: 11/18/23, 10am-4pm

Testing:

When we were practicing shooting the catapult, we noticed that she shaft began to slide out of the tower. It was not reinforced with a shaft collar since it needed to be able to move back in forth while we were finishing the gear box. Now that the gearbox is done, we are able to add the shaft collar to hold it in place.

Overall adjustments:

Our driver, Matt, had to learn how to go over the piece in the middle of the field due to a new weight distribution of the robot. We realized going straight over the center pole no longer works due to the weight distribution, and our wheelie trick no longer works for the same reason. It took a few tries, but we figured out a way to ickly drive up and maneuver the robot to get it over the middle.

We also practiced loading triballs. We realized that the main strategy we should be following is to place triballs in the catapult at a fast pace. We practiced this many times until we were at a comfortable pace.

Flaps for Pushing and Prep for WPI

Today's Goals:

1. Add Flaps for Pushing the Triballs
2. Prepare for WPI Signature Event

Who was here:

- Matt
- John
- Brenna

Time and date: 11/25/23, 10am-4pm

Flaps- the side flaps on the robot are built to be flush to the sides. We made them with the main purpose to push triballs into the goal. They will also help get win point by extending and swiping triballs out of the corner.

They are run by 2 pneumatic reservoirs which are placed on the intake due to weight distribution.The placement of the reservoirs change the center of mass of the robot, making it easier to climb over the middle piece. The flaps also serve as a sled so that the robot can be raised to climb over the middle. There is also a single action piston on each side o the robot that shoot out the flaps. There are rubber bands that retract them.

Prep for WPI

Today is our last meeting before competition season to prepare for the WAVE at WPI Signature Event in Worcester this coming Thursday.

Tournament Preparation:

Tournament - Role Distribution

- Batteries: John
- Freeze Spray: Lazaro
- Alignment tool: Lazaro
- Select Auto: Matthew
- Align Robot for match: Matthew
- Triball placement: Brenna
- Turn off Robot after match: Brenna
- Scouting: All team
- Search for Alliance Partners: All Team
- Drive Team: All Team

Before Match Checklist:

- ❏ Find alliance partner and strategize
- ❏ Have a fully charged battery
- ❏ Plug in battery to the robot
- ❏ Freeze spray motors (if necessary)

Prep for WPI

- ❏ Controller is on and plugged in
- ❏ Select autonomous
- ❏ Make sure field is set up properly
- ❏ Align robot
- ❏ Drive team ready (watch and call out time; position launch of triballs, calculate points and know game strategy)

After Match Checklist:

- ❏ Turn off robot so it rests
- ❏ Set up field
- ❏ Charge battery
- ❏ Charge controller
- ❏ Is there time for Skills run between matches

Driving

We practiced driving. The driving practice has helped get a lot better at getting triballs into the goal.

Judging Practice

After todays meet we will get together to practice judging. Speaking about our roles we feel most strongly about and decide who would speak about what during the judges interview. We all know that we can speak about anything, but some of us are more familiar with specific jobs rather than others. For example Matthew is the main programmer and knows the code better than anyone else on the team.

Iterate the Intake

Today's Goals:

1. Iterate the Intake

Who was here:

- Matt
- John
- Lazaro
- Brenna

Time and date: 11/25/23, 12pm-4pm

11/25 fixed pneumatics

Shooting the catapult countless times causes the shaft to slide out of the tower. It was not reinforced with a shaft collar before because it needed to be able to move back and forth a little bit to finish up the gear box but now since the gear box was finished we could put the shaft collar to fjord it in place.

Overall adjustments

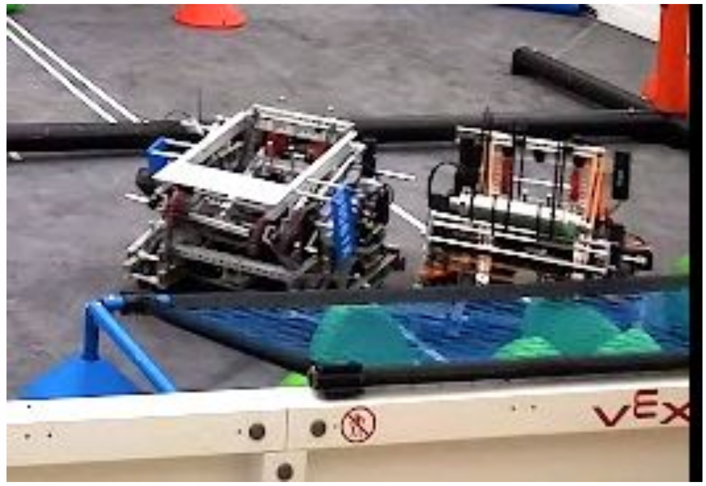
Had to relearn how to go over middle piece due to different weight distribution of the robots. We realized that full speed over the center pole no longer works since the weight distribution has changed and our wheelie truck no longer works because of the weight as well so we figured out a way to carry the intertwined which flips the robot over the middle.

Practiced loading triballs. We realized that the main strategy of most matches is to place triballs in your catapult while it moves at a fast pace so we practiced this for a good amount of time as practice makes perfect

Mount Academy Competition

Todays goal:

1. Competition



Who was here:

- Matt
- Lazaro

Time and Date: Saturday Dec 9th

Match results:

Our team went 3/3 placing us in rank 11, allowing us to choose 78792K Mount Academy Eagles K as our alliance partner. With Mount Academy Eagles K we made it to quarterfinals where we faced 78792E Mount Academy Eagles E and 6277C Hard wired. Unfortunately we lost by 99 points.

Mount Academy VRC Over Under Qualifier

Qualifier #6	Dec 9th at 10:21 AM	32563A	**97140A**	101	6277C	10504A	146
Qualifier #14	Dec 9th at 11:03 AM	6527B	18693A	27	**97140A**	99561X	100
Qualifier #19	Dec 9th at 11:26 AM	18693C	6277B	99	**97140A**	6527A	81
Qualifier #31	Dec 9th at 1:12 PM	97140B	**97140A**	39	25565A	85215A	78
Qualifier #37	Dec 9th at 1:42 PM	**97140A**	99561Z	127	78792T	32563D	68
Qualifier #43	Dec 9th at 2:13 PM	78792E	**97140A**	126	15981A	32563B	69
QF #1-1	Dec 9th at 3:47 PM	78792E	6277C	169	**97140A**	78792K	77
R16 #2-1	Dec 9th at 3:22 PM	18693A	10504B	71	**97140A**	78792K	91

Rank	11
WP / AP / SP	7 / 36 / 385

Mount Academy Competition Continued

Quarterfinal results:

We decided as a whole that 78792K Mount Academy Eagles K should load the tri balls, thus allowing us 97140A to push the tri balls under the goal. In the match 6277C Hard wired blocked our teammate thus harming our chances of getting points under the goal, while Hard wired was blocking 78792E Mount Academy Eagles E was shooting over the tri balls and getting them under the goal. Last thirty seconds Hard wired hung on the bar giving them an extra edge.

Findings after Mount Academy:

We realized that we needed a different robot one that used a four bar with either a kicker or a flywheel. The reason behind our realization was that the robots we saw like 78792E Mount Academy Eagles E used a consistent kicker and a bunch of other teams using for bar with a kicker or flywheel. Another reason behind our decision was the fact that our catapult wasn't as consistent as we wanted it to be which was a major reason behind us losing matches.

New Year, New Robot

Today's Goals:

1. Redesign robot
2. Review film

Who was here:

- Matt
- John
- Brenna

Time and date: 12/30/23, 10am-4pm

Should we redesign our robot?

After our most recent competition at Mount Academy, we realized that our six wheel drive had gears that were spaced just too close to each other so that they would rub against one another and create unnecessary friction. Because of this, we decided to change it eight smaller wheels because this would allow for the least possible friction.

Our new gear ratio is 4:3, 600 rpm motors geared down to 450 rpm.

We began to work on a four bar in order to raise and lower our future kicker in order to prevent blockage. The hardest part of today's building was trying to get the right spacing for the wheels. By the end of our day, we successfully had a drive train.

New Year, New Robot

Old or New Robot Design

Decision Matrix

	Old Robot	New Robot Design
Durability	4	5
Strength	3	5
Speed	4	4
Strain on Motors	2	4
Effectiveness	2	5
Total	15	23

As seen in the decision matrix above, the new robot design seems to be better than the last design. Our old robot was not as effective as we thought it would be so we began designing a new one.

We decided to start with the base of our robot, the chassis. The process is illustrated on the following pages.

New Year, New Robot:

Design Process

We made six wheels to use in our chassis. To make each we used the following parts:

Keps Nut
x4

Keps nuts include a built-in locking washer to protect against loosening from vibrations. In many cases, Keps nuts can also be tightened without the need for a wrench. Fully compatible with all VEX Robotics and VEX V5 hardware. Legal for use in the VEX Robotics Competition. **11/32" hex width** is compatible with all standard VEX tools.

1 ½ in. Screws
x4

There's nothing more frustrating than a screw with a stripped head. With VEX Star Drive Screws, this becomes a thing of the past. These star drive screws are able to withstand a greater amount of torque than standard hexagonal VEX screws, allowing builders to truly 'lock down' their mechanisms.

Drive Shafts
x1

VEX Square Drive Shafts have rounded corners which allow them to easily spin in a round hole, while locking into a square hole. Insert these into a motor to power all of your applications.

- Use the 12" to make your own custom length shafts
- Works with motors, wheels, gears, and bearings

¼ in. Spacer
x4

Spacers are used to create a space between two objects, often to properly position them. Available in various lengths.

48T High Strength Gears
x1

Build mechanisms capable of achieving higher torque or speed than ever before with **High Strength Gears** - lift heavier loads and survive bigger impacts with the additional gear ratio options provided by the largest high strength gear available.

Omni Wheels
x4

Omni-Directional wheels roll forward like normal wheels, but slide sideways with almost no friction (no skidding during turns). Use these wheels to make your robot turn smoothly or build a holonomic drivetrain.

VEXpro Omni-Directional Wheels are manufactured from Glass-filled Nylon with high-traction rubber rollers. Compatible with VEXpro VersaHubs for driving with a sprocket or can be used with bearings for use on an axle.

Source: [Home - VEX Robotics]

New Year, New Robot:

Design Process

C Channel
x3

VEX C-Channel has holes on 0.500" increments. This structural member's excellent strength and bending resistance is perfect for building robust robots.

- Multiple sizes available, in two different material types
- Made from cold rolled steel, or 5052-H32 Aluminum
- Each channel is segmented into cuttable 2.5" pieces

The **High Strength Shaft Bearing** is a larger version of the Bearing Flat that is designed for the 0.25" High Strength Shafts.

VEX V5 2", 3", and 4" High Strength Shafts are actually designed about 1mm shorter than their respective 2", 3", and 4" #8-32 Standoffs.

This means that if you use standoffs to hold together two pieces of metal, the High Strength Shaft can rest on High Strength Shaft Bearings attached to those two pieces without any cutting required.

- Mounts directly onto VEX V5 structure
- Low friction allows shafts to turn smoothly
- Mount with Screws & Nuts or Attachment Rivets

High Strength
Bearings
x14

Omni
Wheels
x4

Omni-Directional wheels roll forward like normal wheels, but slide sideways with almost no friction (no skidding during turns). Use these wheels to make your robot turn smoothly or build a holonomic drivetrain.

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Source: Home - VEX Robotics

New Year, New Robot:

Design Process

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Keps Nut
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x4

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- Use the 12" to make your own custom length shafts
- Works with motors, wheels, gears, and bearings

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x1

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48T High Strength Gears
x1

New Year, New Robot:

Design Process

Mounting Hardware Guide

- Mounting (1) Keyed or Hex VersaHub - 1/4" or 3/8" long screw
- Mounting (1) Plate Sprocket and (1) Sprocket VersaHub - 1" or 1.25" long screw
- Mounting (2) Plate Sprockets and (2) Sprocket Versahubs - 1.5" or 1.75" long screw

These Omni-Directional wheels were designed from the ground up to give the smoothest ride possible. VEX's construction method uses a dual roller design that allows for a constant contact patch with a narrow profile. Each roller is tailored for the individual wheel diameter, and provides the correct, constant radius. We don't share rollers between wheel types -- these wheels aren't "almost round" they're actually round. This smooth-ride provides higher efficiency and reduces wasted power!

Omni-Directional wheel assembly hardware is separate from sprocket mounting hardware. Sprockets are screwed into captive 8-32 standoffs. This allows for easy removal and replacement of sprockets without disassembling the entire wheel. No more worrying about your whole wheel falling apart just because we wanted to remove the sprocket.

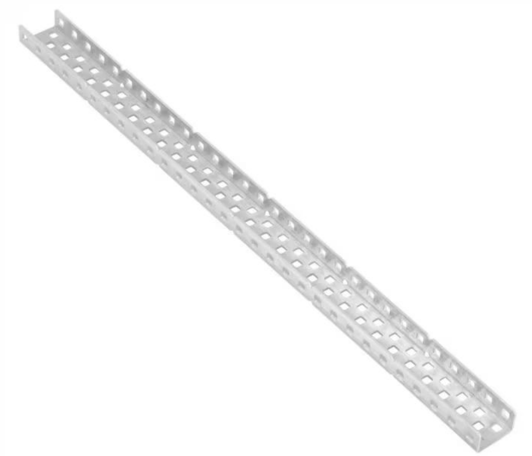
Source: Home - VEX Robotics

New Year, New Robot:

Design Process

We began building the chassis with the parts listed in the pages above.

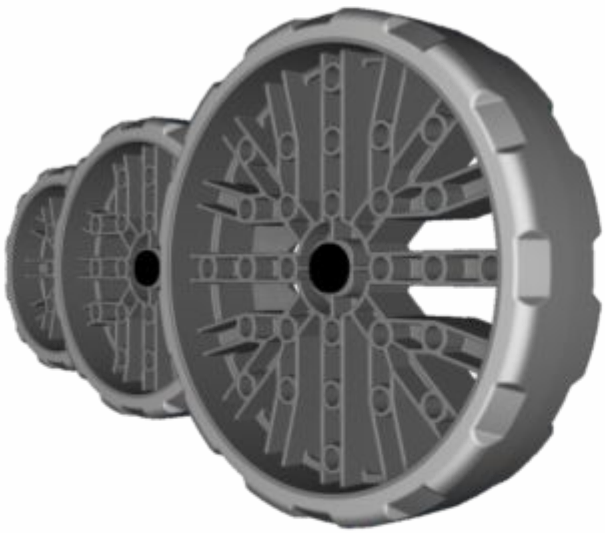
We started by building our kenny wheel. We put together a wheel and a gear with four spacers in between. We then put the screws through the spacers, and attached them with nuts. Then we put a shaft through each. We repeated this process three more times for a total of four kenny wheels.



We used 4 c- channels and cut them to size (15in). We then attached the kenny wheels to the c-channel.We placed kenny wheels on the farthest side of the channels with two traction wheels in between. We then put 36T gears in between each of the kenny wheels and traction wheels for a final gear ratio of 4:3.

We chose this design because with six wheels there was too much friction in the drivetrain, making our robot less effective. Our new design, which uses eight wheels, has less friction and makes our robot work better.

We repeated this process to make the other half of our chassis. We attached another c-channel on the top of each using half inch screws and two inch standoffs. How we connected them is discussed on the next page.



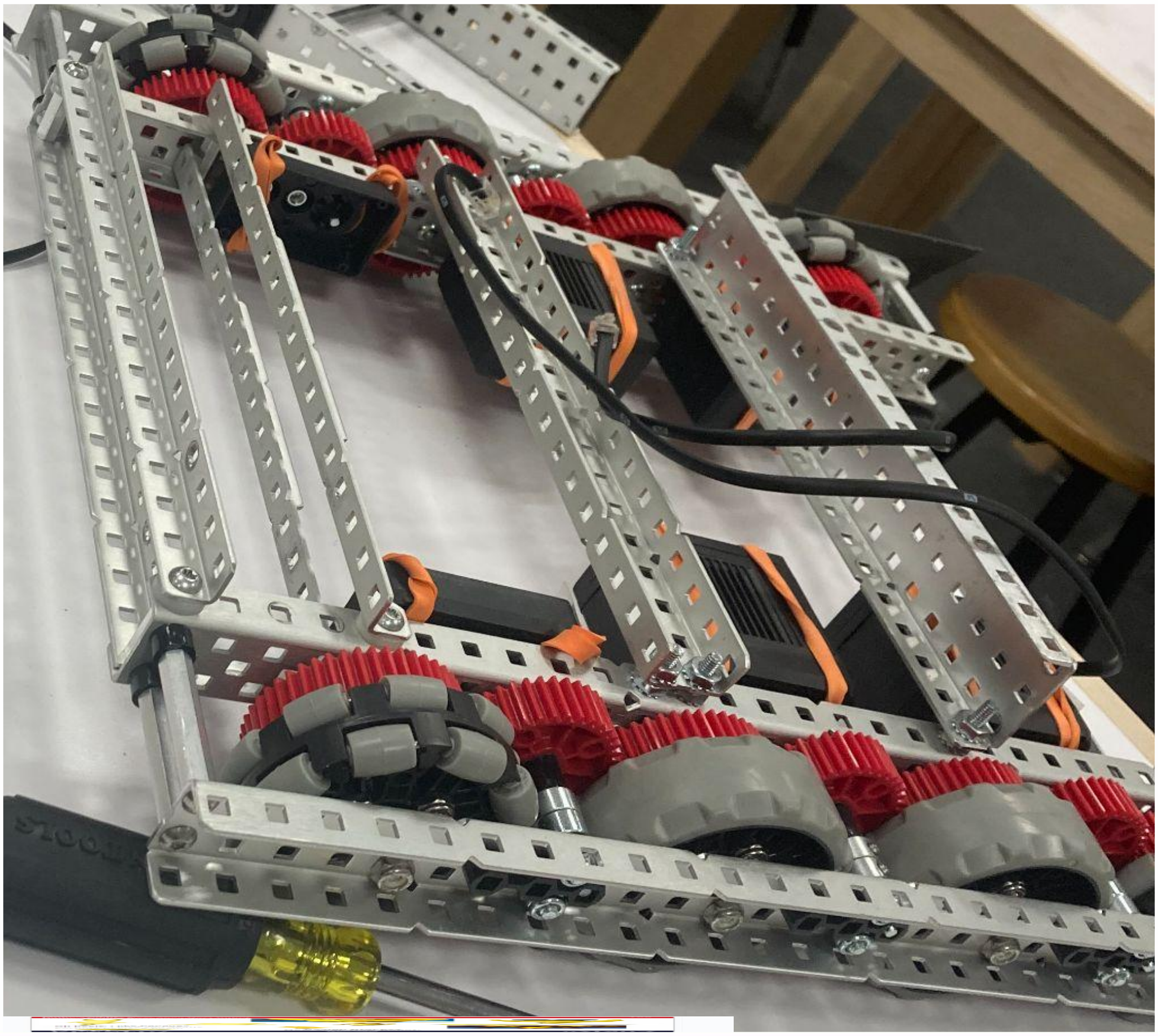
Name: Brenna Rosario, John Pollack
Date: 12/30/23
Project Name: New Year, New Robot
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

New Year, New Robot:

Design Process

After our wheels were attached and constructed, we decided to connect the two sides with c-channels. Starting with the back, we used a 1x3x1x17 c-channel for the back, a 1x2x1x16 for the middle, and we cut a 1x2x1x16 in half for the front.

After connecting the sides, we attached three 600 rpm motors on each side. Our next step was to build a four bar mechanism in order to raise and lower our kicker easier, denying the ability to be blocked. This is discussed on the next page.



New Year, New Robot:

Design Process: 4 Bar

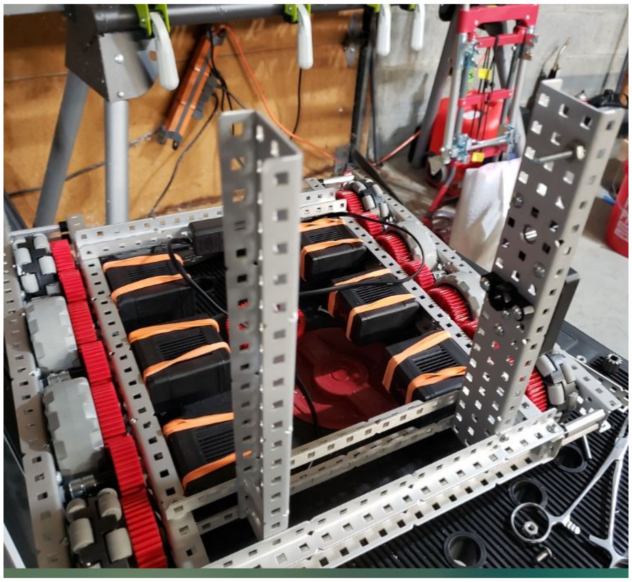
4 Bar

The team has decided to implement a 4-bar mechanism for the new robot, featuring a kicker at the arm's top. This design offers versatility in shooting triballs. With the arm down, we can aim for precision just over the middle barrier, while lifting the arm maximizes the arc to clear most blockers.

We opted for simplicity, avoiding double reverse bars and scissor lifts. Some members on the team built a double reverse bar in past seasons and they learned lessons on why a simple 4 bar is better. Matt suggested offsetting the 4-bar geometry, creating a steeper angle when the arm is raised for a more exaggerated arc to overcome blockers.

Today's focus is on constructing a sturdy tower as the 4-bar base, emphasizing the desired geometry. We aim to easily navigate under side barriers and elevate the arm as high as possible. Discussions will include the potential use of the arm for elevation.

Our primary constraint is a single 11W motor for power, with potential consideration for pneumatics in the future. First things first, we're tackling the foundation of the build.



New Year, New Robot:

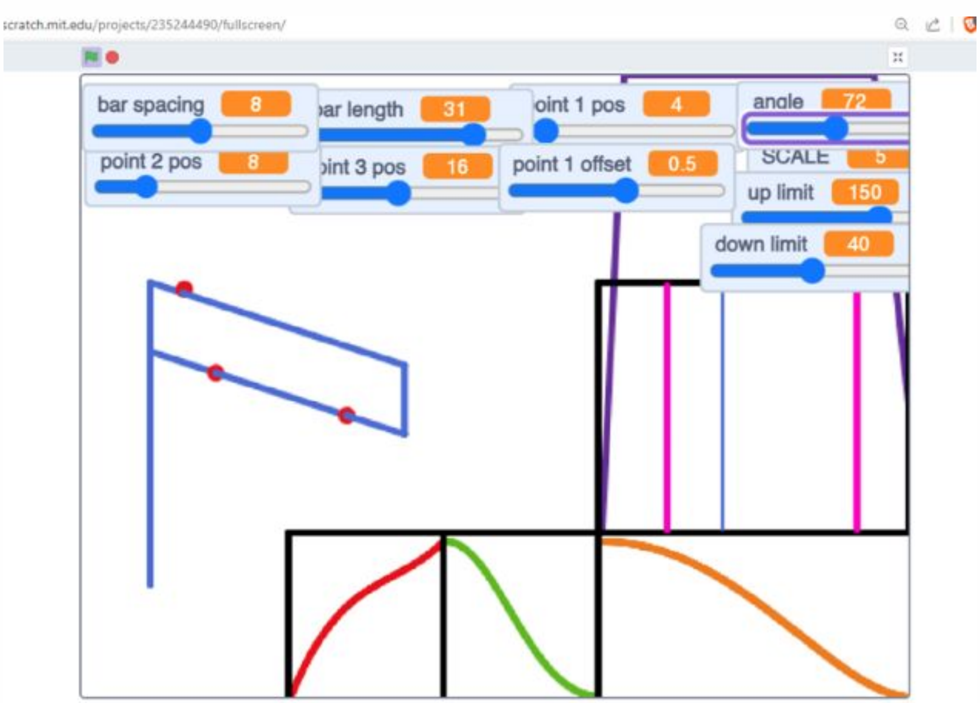
Design Process: 4 Bar

We've chosen High Strength shafts, ball bearings for support, and screw joints with sintered bronze bushings to minimize friction in our 4-bar mechanism. This is crucial for running the entire system on a single 11 Watts motor.

Our initial step involved creating a geometrical mockup, and we've begun calculating rubber banding. Utilizing the helpful rubber banding visual calculators at:

- [Scratch Project 1](https://scratch.mit.edu/projects/235244490)
- [Scratch Project 2](https://scratch.mit.edu/projects/186027447)
- [Scratch Project 3](https://scratch.mit.edu/projects/165255545)
- [Scratch Project 4](https://scratch.mit.edu/projects/202330699)

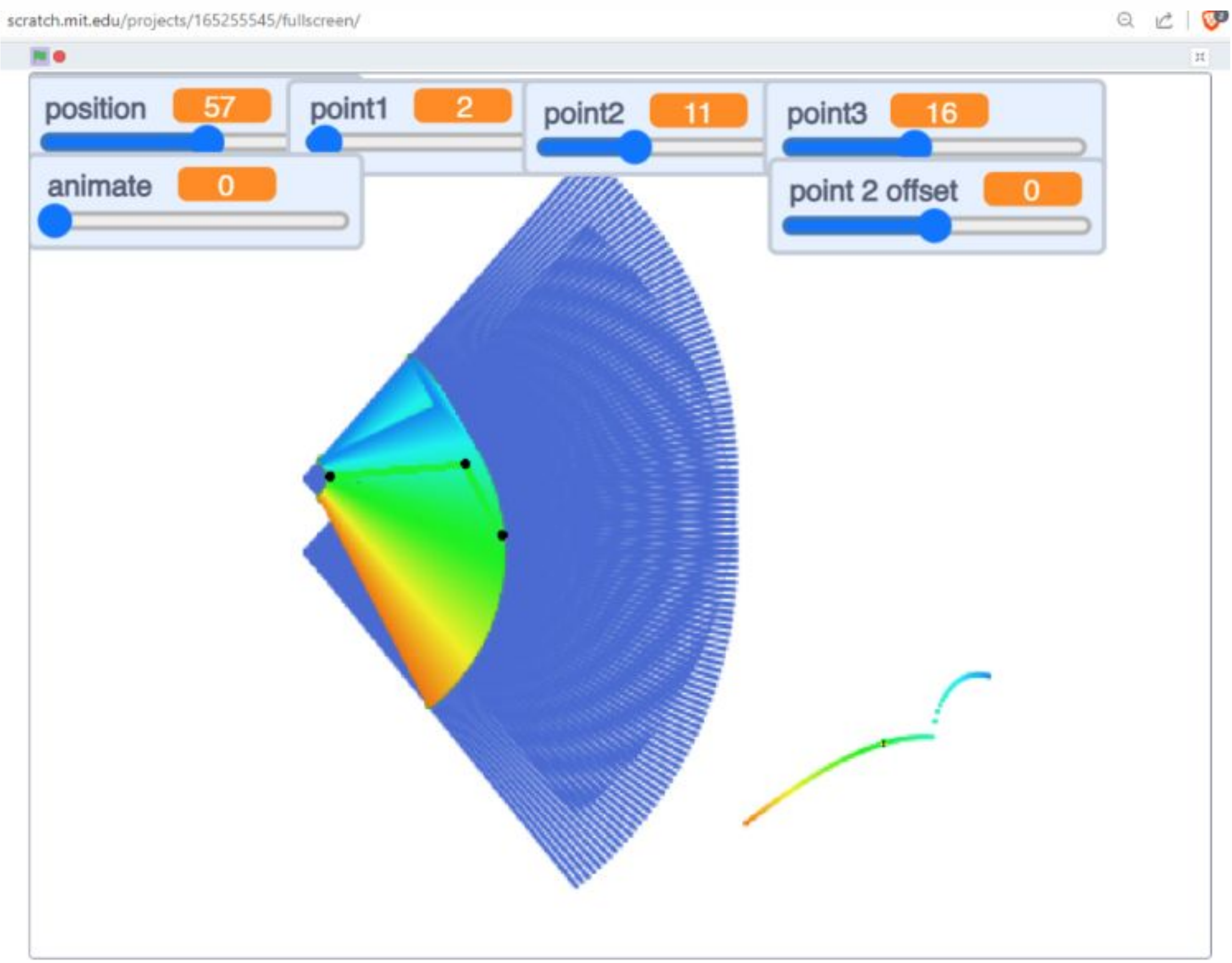
Traditionally, you'd aim for less force at the lift's bottom and top to optimize lifting force and avoid straining the motor. We've taken a non-traditional approach, calculating rubber banding to keep the arm elevated without motor power. This eases the system, especially when the arm needs to stay up for shooting over blockers.



New Year, New Robot:

Design Process: 4 Bar

Ultimately, we went with the banding configuration based on the first visualizer. Although the second visual calculator had the triangle's points reversed, it provided valuable insights into how rubber bands impact forces by altering geometry and, consequently, the triangle's perimeter.



New Year, New Robot:

Design Process: 4 Bar

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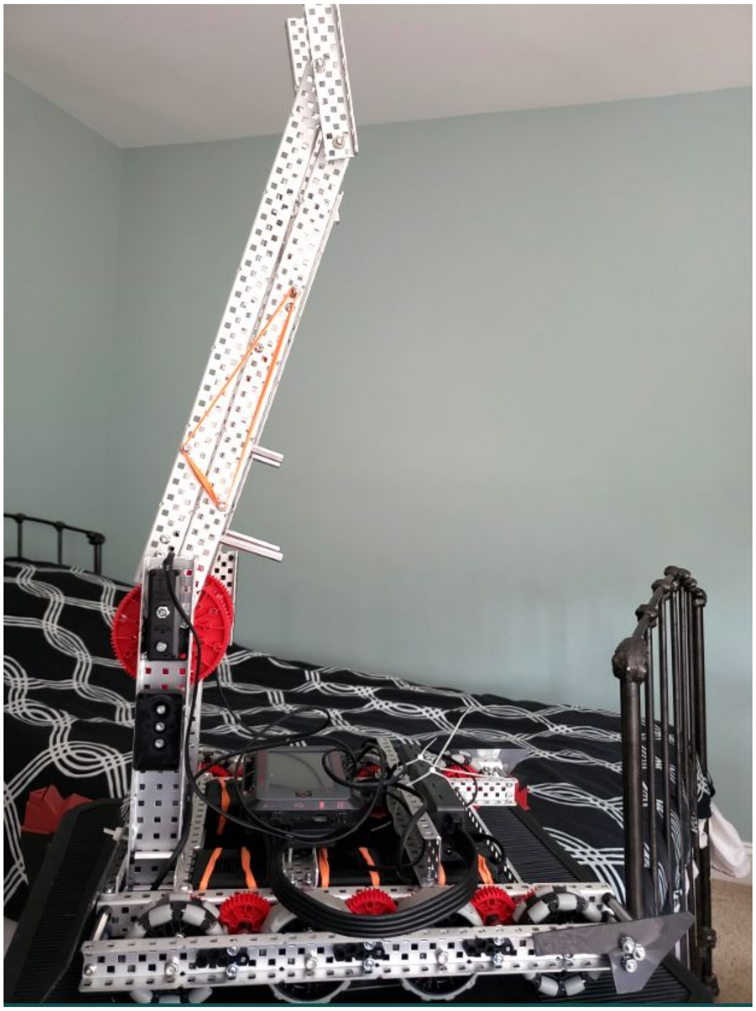
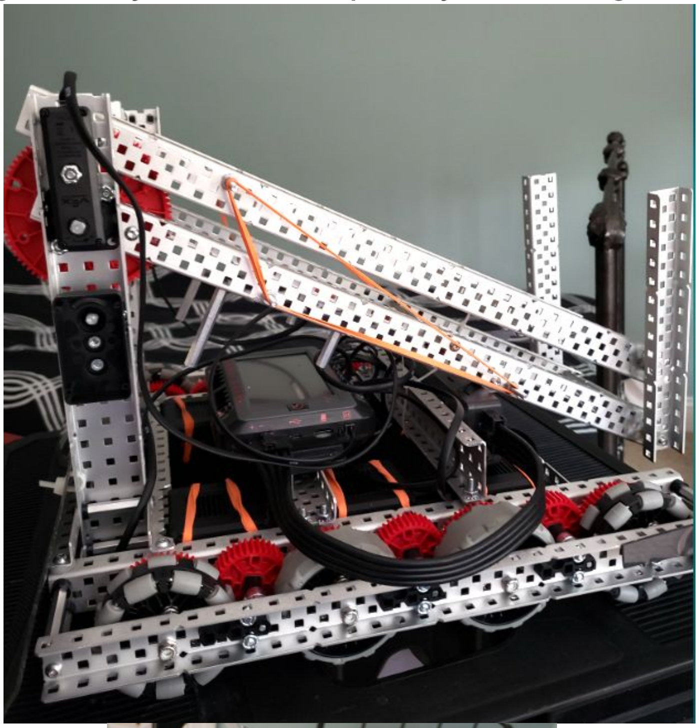




Design Process: Kicker

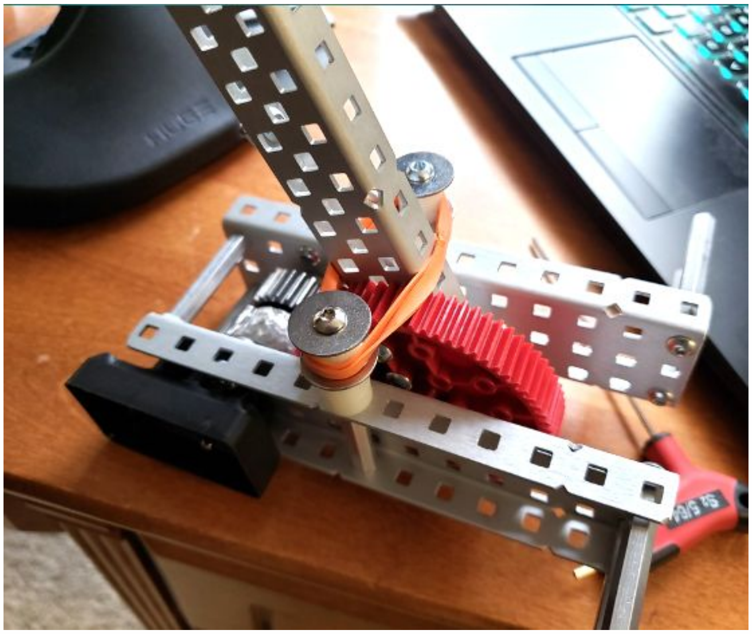
Today's Goals:

1. Solidify base
2. Work on kicker
3. Optical sensor

Who was here:

- Matt
- John
- Brenna

Time and date: 1/1/24, 10am-4pm



Happy New Year!

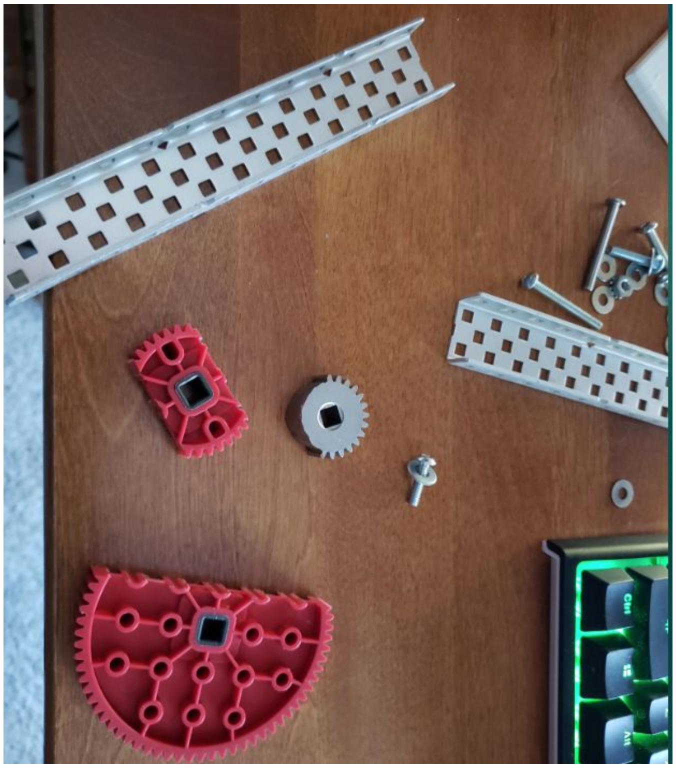
Today, we dove into building, attaching, and programming the kicker for our robot. We're also exploring ideas to strategically place air reservoirs inside the base and mount the battery to keep all the heavy components low and snug.

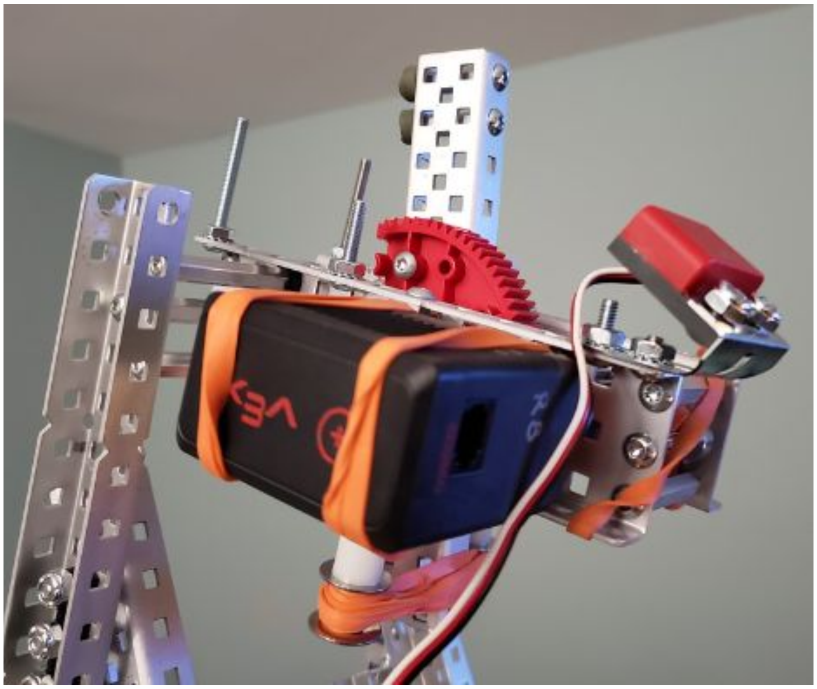
For the kicker assembly, we started with a basic setup. A shaved 24T metal gear acts as a slipgear, slipping on a 72T gear that engages the kicker. The kicker itself is a simple c-channel piece pulled back by a series of rubber bands, resembling a slingshot.

Drawing inspiration from Matt's experience in Turning Point, where he competed solo as team 15239A RoboBaller, we learned from a linear puncher mishap. Hard stops and dry-firing wreaked havoc on the robot, so Matt innovatively used rubber bands as a stopper. Applying the same concept to our kicker, instead of a conventional hard stop, we're using the same rubber bands that initially provide kinetic energy as a protective stopper. This way, any unspent energy is absorbed back by the rubber bands, acting as sacrificial protection for the rest of the robot.

Design Process: Kicker Prototyping and Iterating

Once the idea underwent testing, we delved into prototyping and iterating. Our initial focus was on eliminating any slop in the system. To achieve this, we introduced a cut gear as an additional bushing to prevent the kicker from bending sideways. Additionally, we modified the large 72T gear, cutting away the unused part of the teeth to avoid interference with the triball. Further refinement involved shaving a few more teeth from the slipgear for optimal performance.

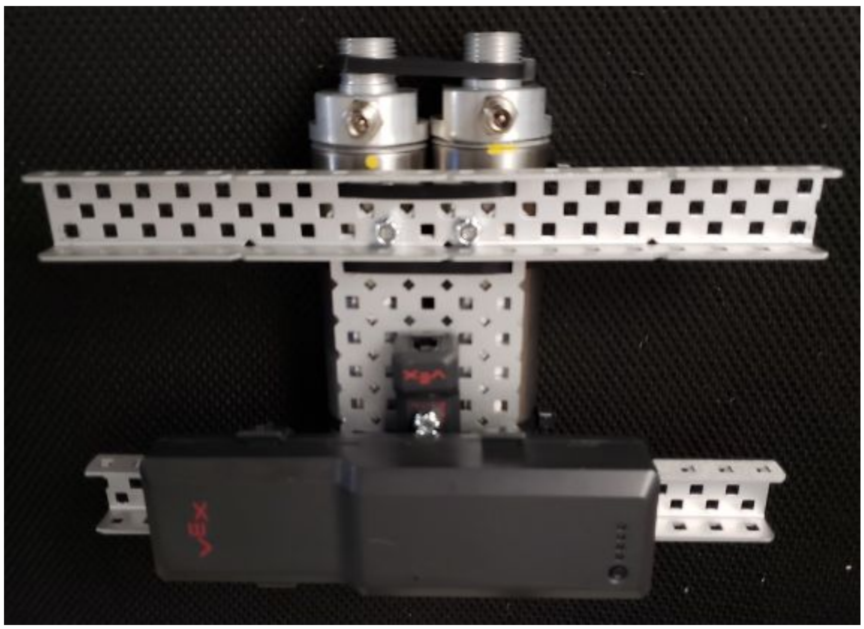


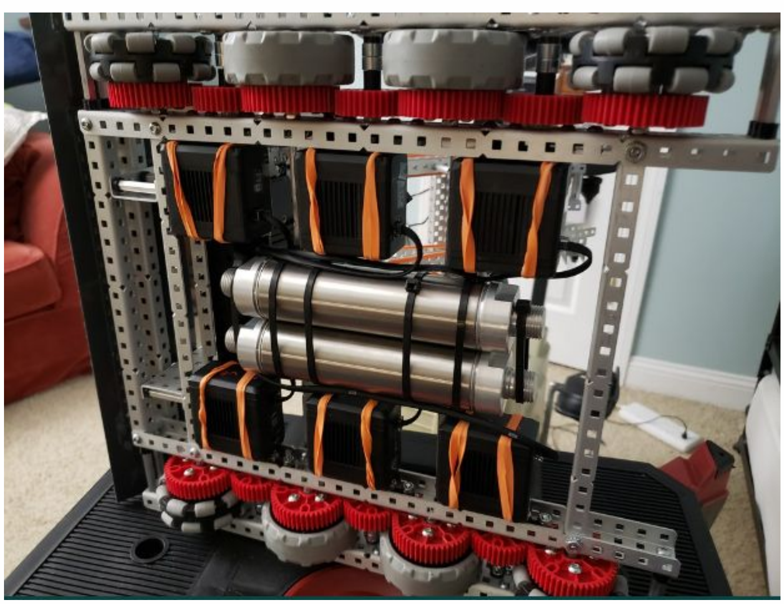


Following a dozen or so iterations and tests, we arrived at the final version of the kicker. The sling part was repositioned to the bottom, away from the triball, and a limit switch was integrated to sense the armed position, enabling controlled shots. While awaiting black rubber stoppers from UPS, we utilized other elements for kicker end testing (pictured are green rubber joints cut in half). Offset screws were employed as triball support, offering the flexibility to adjust for the perfect angle.

Design Process: Air Reservoirs

Meanwhile, team focused on incorporating two air reservoirs (for future pneumatic use), an IMU sensor, and battery clips onto a removable support structure designed to fit seamlessly in the middle of the chassis. To accommodate these additions, we revamped all motor cables and implemented effective wire management for a tidy setup.





Design Process: Kicker Testing and Optical Sensor

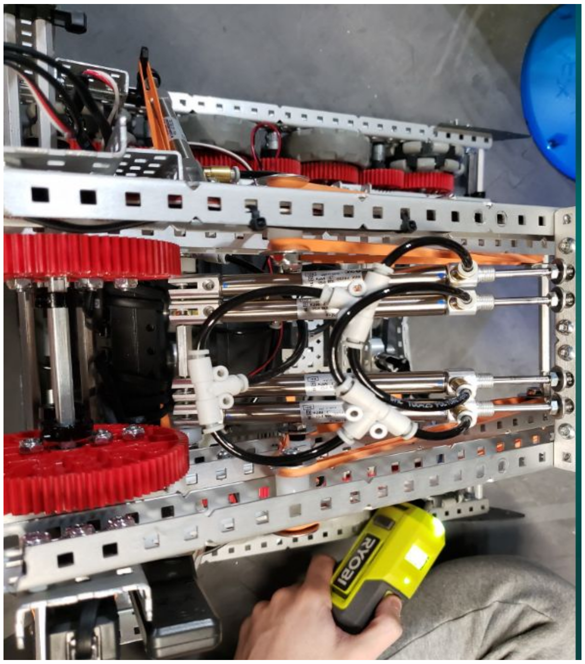
After extensive kicker testing, we discovered the challenge of placing triballs with perfect timing. The team decided to simplify the process using sensors and clever coding. Initially considering a limit switch sensor, we later opted for an optical sensor – the V5 optical sensor, with precise object detection. Placed beneath the triball location, the kicker remains armed. Upon sensing an object, it waits briefly for the user's hand removal, then shoots the kicker once and returns to the armed position, ready for the next object.

The entire team enthusiastically embraced the idea of a unique automated kicker, leading to numerous iterations. The resulting code proved elegantly simple and efficient, featuring two main functions. The first kicks once, briefly spinning the motor to allow the gear to slip and kick the triball. The motor continues until the limit switch is triggered, stopping with COAST to prevent overworking and overheating. The ratchet engages, halting the slipgear, leaving the kicker ready for the next shot.

The second function seamlessly activates the first function the moment the optical sensor detects a triball on top of it.

Name: Matthew Achim
Project Name:Design Process: Kicker Testing and Optical Sensor
Date: 1/1/24
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

New Design: Pneumatic Climb Assist



Today's Goals:

1. Experimenting with Pneumatics
2. Incorporating Pneumatics

Who was here:

- Matt
- John

Time and date: 1/2/24, 3pm-9pm

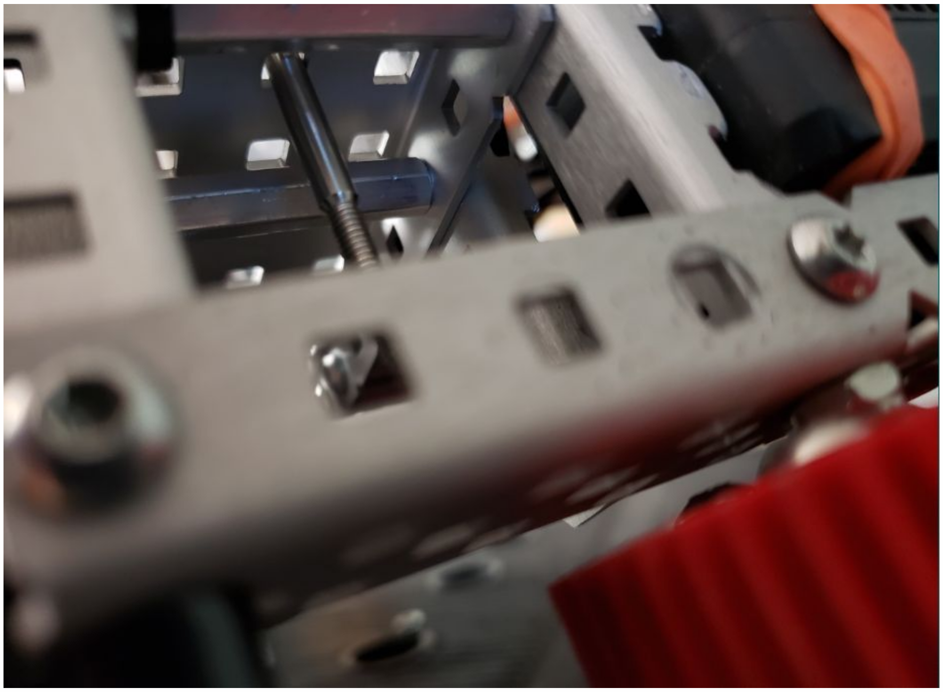
During arm testing, we encountered a challenge – one motor didn't have sufficient torque to elevate the robot, even with a ratchet. Actuating a one-way ratchet was also a hurdle due to motor power constraints and limited space for PTO mechanisms on our compact robot.

Introducing pneumatics became the solution. We experimented with with two reservoirs and air cylinders. VEX pneumatics kits were sold out so we used the legacy SMC equipment.

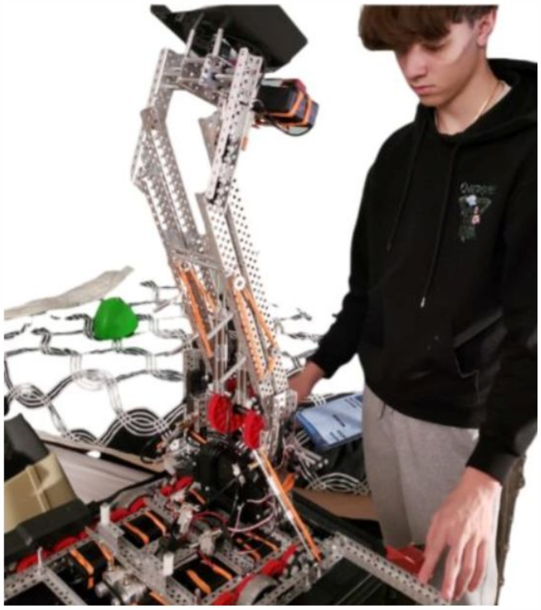
In our quest to enhance the arm motor's performance in grabbing and lifting the elevation bar, Matt suggested a brilliant idea – replicating the triangle rubber bands' effect with air. Placing one air cylinder where the 4-bar mechanism's bars come together showed promise, but a single cylinder fell short. Undeterred, we installed a staggering four air cylinders, creating such force that it even bent the one-hole angle used as mounting points. Reinforcing the system with c-channels strengthened by our box screw setup proved successful. The arm could now lift the entire robot mass, enabling elevation. Though the robot ended up in a clumsy pose, fine adjustments are on the horizon.

New Design: Pneumatic Climb Assist

Opting for a straightforward solution, we incorporated a one-time-activated ratchet for climbing. The setup involves an air cylinder retracting and engaging the ratchet simultaneously as the four cylinders exert force on the arm. The concept relies on the fact that, at the driver control period's end, the triports remain untouched, and the air cylinders should stay inflated. Even in the event of air loss, the ratchet serves to keep the robot securely clamped to the bar. We positioned this uncomplicated mechanism at the bottom of the chassis to maintain some containment for the tubes and extra cables.



New Design: Additional Game Strategy Elements



Today's Goals:

1. Add vertical wings
2. Add triball loading guider
3. Add additional game strategy elements

Who was here:

- Matt

Time and date: 1/6/24,10am-4pm

Our next project involves vertical wings, a departure from the horizontal wings on our initial robot.

Initially, we avoided combining the plastic sled used for climbing the middle barrier with the wings. The concern was that if the robot approached the barrier at an angle, the wings might open prematurely, hindering the climb.

Additionally, we considered the issue of air depletion from the reservoirs affecting the power of air cylinders. Without a locking mechanism, this could compromise pushing power. Opting for vertical wings addresses these concerns. Moreover, we see the strategic advantage of using vertical wings to lock onto the corner loading bar, providing three tactical benefits:

1. Matching load without being easily pushed by opposing robots.

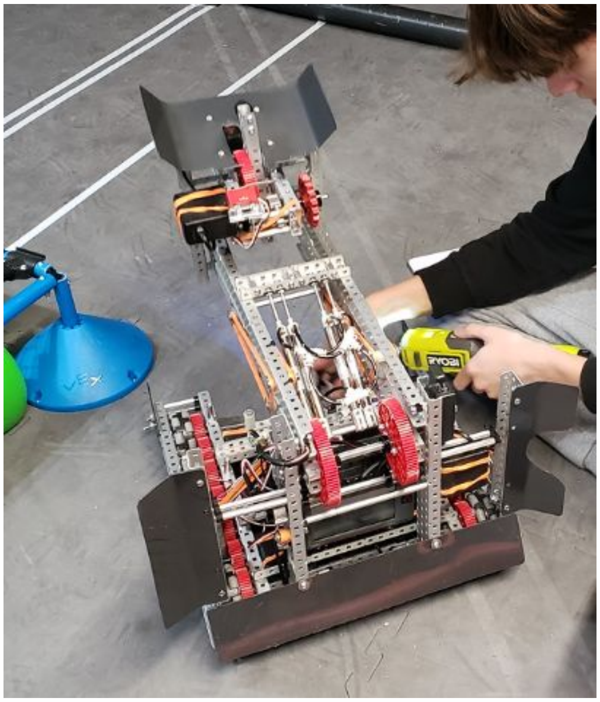
2. Maintaining constant contact with the bar at the loading zone to avoid violation calls.

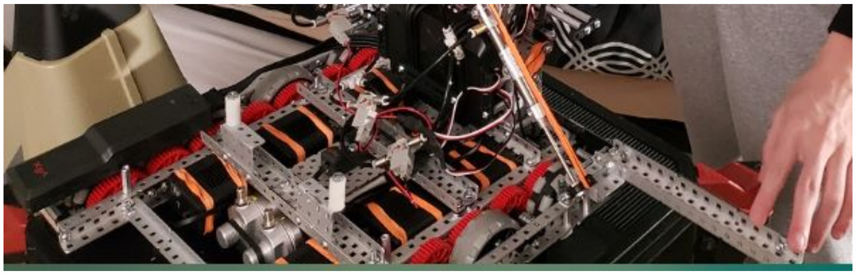
3. Exploring more creative positions for matchloading.

New Design: Game Strategy Elements and Testing

In the process of developing the wings mechanism, we simultaneously integrated plastic elements into the robot:

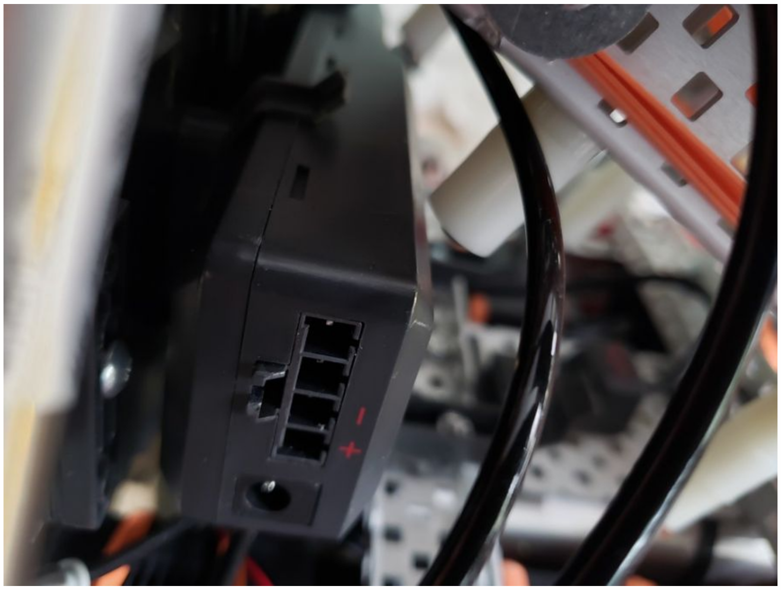
- A "hat" was added to the kicker, enhancing positioning and guiding for the triballs.
- A substantial "plow" was introduced at the back of the robot, facilitating the easy lifting of triballs over the middle barrier through strategic ramming without the need for climbing.
- Mini plows were measured, cut, and bent to serve as extensions to the main plow, contributing to the functionality of the wings.





TESTING: The remainder of today's session was dedicated to thorough testing of all the components we swiftly assembled. It turned out to be a significant success. Next meeting we fix the issues we discovered while testing.

New Robot: Mechanical/Electrical Issues and Solutions



Today's Goals:

1) **Analyze all mechanical/electrical problems**
2) **Fix mechanical/electrical problems**

Who was here:

- Matt
- John
- Lazaro

Time and date: 1/15/24, 10am-4pm

Addressing the list of mechanical/electrical issues:

ISSUE 1) One of the elevation stoppers we added to the arm is touching the battery not allowing the arm to lower all the way to the mechanical stop position. We are concerned that it might damage components. Also it seems that it is bumping the brain as the battery is now attached directly to the back of the brain. It is also possibly the cause for the port disconnects as the bump might move the fragile port connectors.

SOLUTION: We shortened the back stoppers.

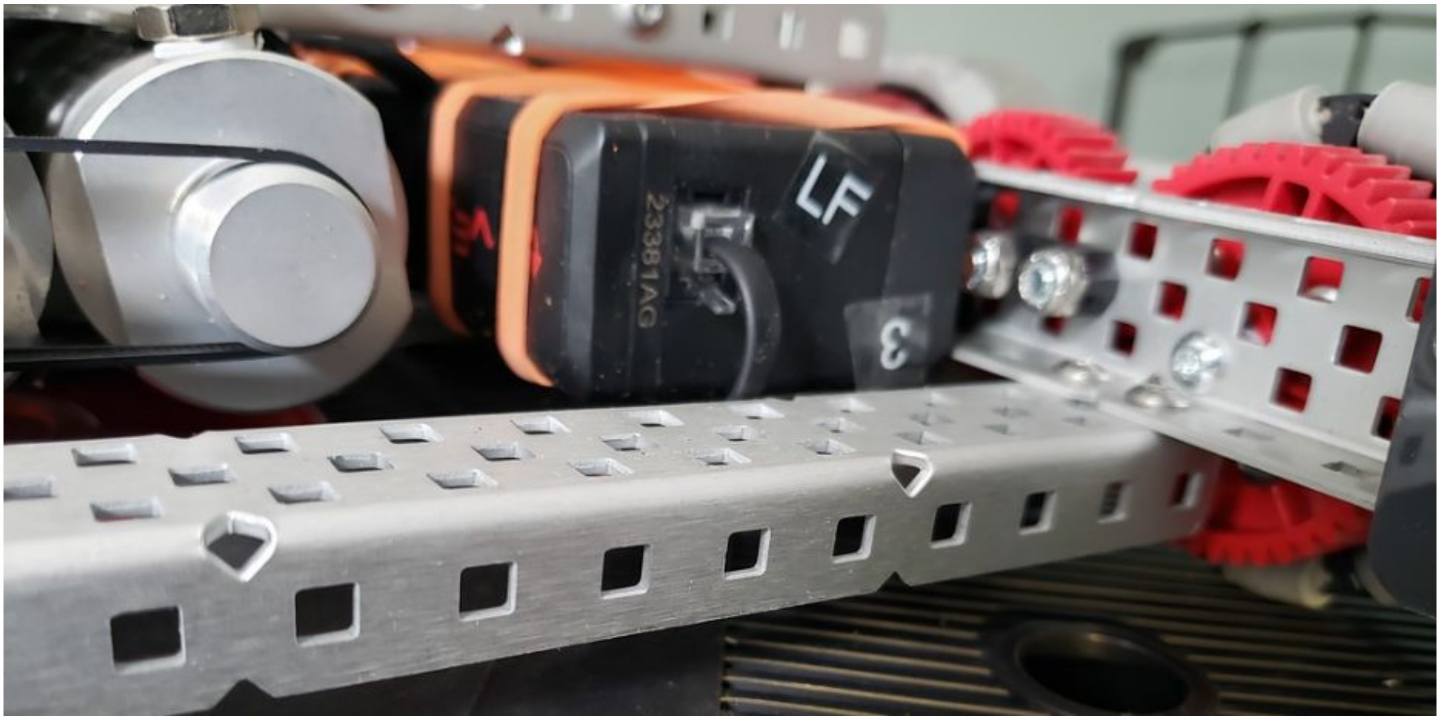
ISSUE 2) The elevation stoppers are also slightly bending.

SOLUTION: We used our classic box-bolt technique by adding a standoff inside the c-channel. This ads massive strength to the system.

New Robot: Mechanical/Electrical Issues and Solutions

ISSUE 3) The one hole angle we used to support the chassis at the very front bottom of the robot (we used a low profile angle while planning a passive intake) bent to the point it self-destructed. While pushing triballs into goals, we noticed that fields are not built/assembled equally so in some competitions it is extremely hard to push triballs under side bars. While trying to gain pushing power and momentum we bent the front of the robot.

SOLUTION: We removed the bent pieces and added a strong c-channel and braced it in 4 points on the chassis.

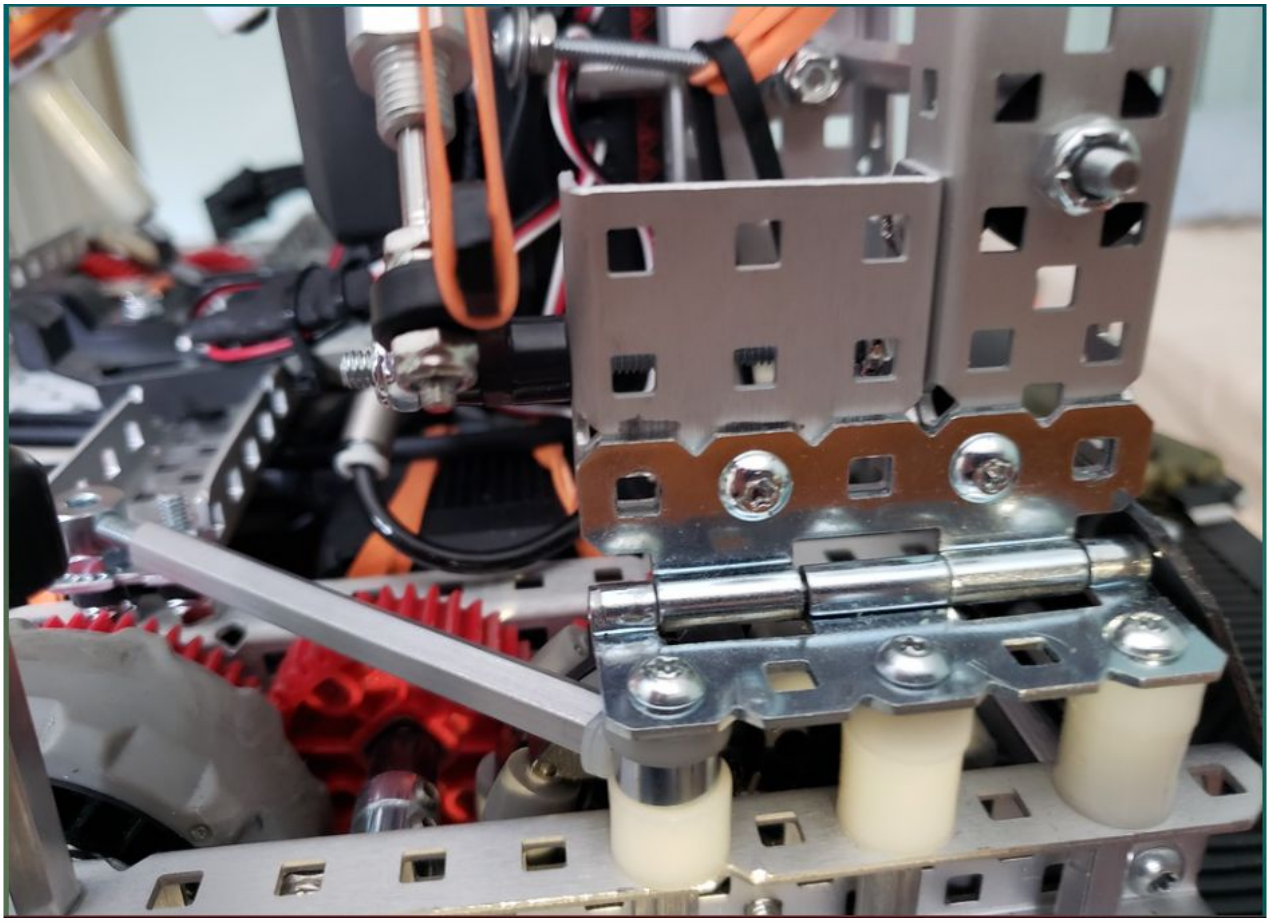


New Robot: Mechanical/Electrical Issues and Solutions

ISSUE 4) Wings bent. This is our second iteration of the wings and while slightly better than the first, wings still bend.

SOLUTION: As an immediate fix we replaced retaining screws with shoulder screws as we noticed what appears to be a bend is actually metal shifting because of the VEX inherent slop due to the square holes being larger than the diameter of a standard screw. Shoulder screws eliminate that slop.

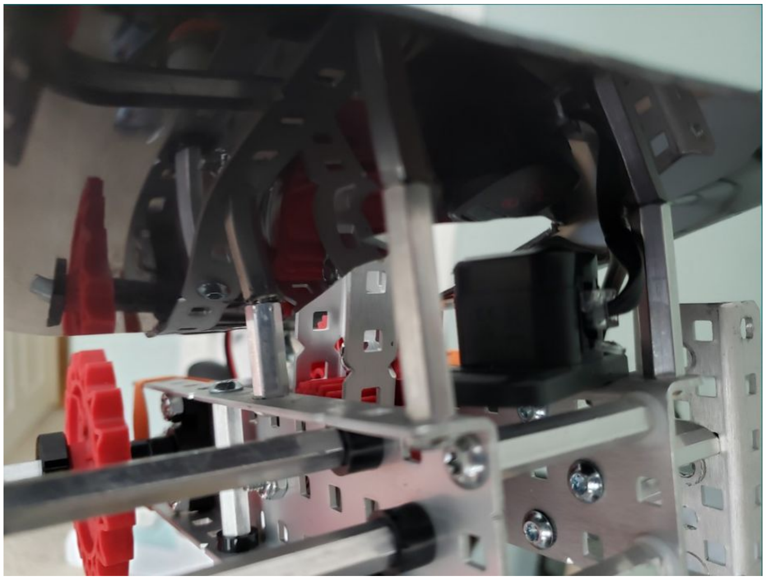
After a few iterations we also added a diagonal cross member using a clever combination of shaft collars, hex standoffs and spacers, which should stiffen the wing hinge mechanism considerably.

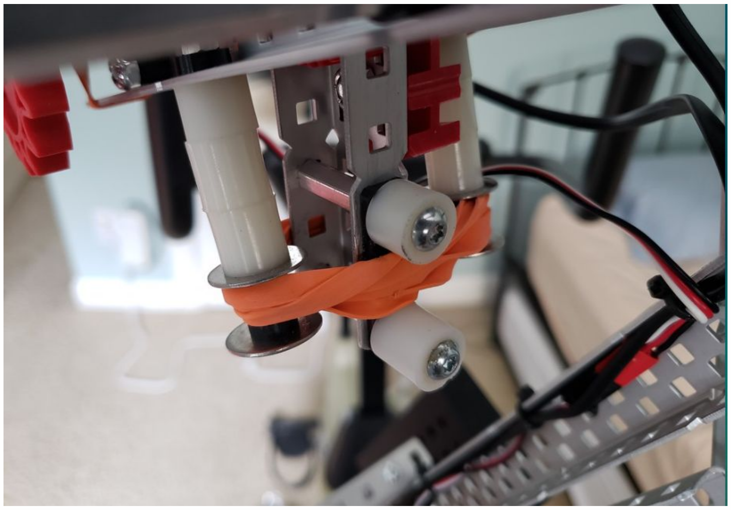


New Robot: Mechanical/Electrical Issues and Solutions

ISSUE 5) Dryfiring the triball kicker hits the color sensor we utilize as an object detector. This is most likely the cause for the intermittent sensor disconnects as the VEX V5 connections are extremely fragile.

SOLUTION: As much as we would like to eliminate dryfiring, we know that in the real world this is not feasible. As such, we found another position for the sensor where it will not be in contact with the kicker arm.





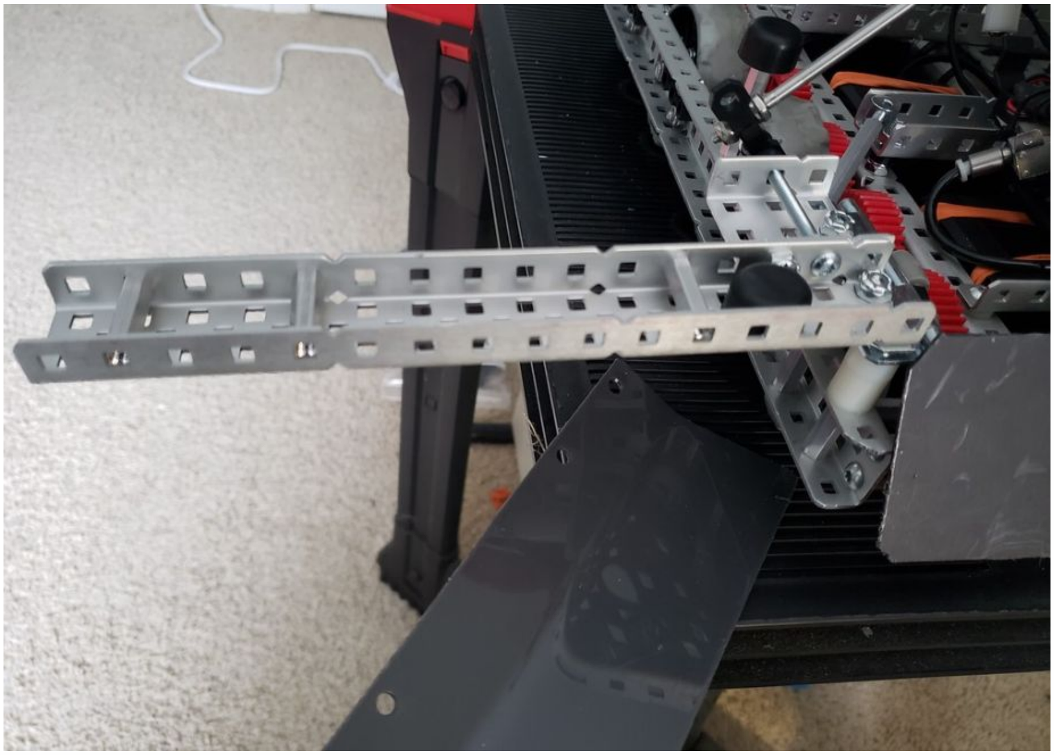
ISSUE 6) The rubberbands that form the sling on our slingshot kicker constantly rip and need frequent replacement.

SOLUTION: We rounded and filed with a super fine sandpaper every potential sharp corner and element.

New Robot: Mechanical/Electrical Issues and Solutions

ISSUE 7) While working on our skills runs we realized the plow style extensions on our wings that allow for easy plowing of triballs over the barrier are less useful in skills where the most important role of the wings is shoving under goal bars. We decided to use the wings without the plastic flaps. But it is slightly uncomfortable to remove 8 screws and nuts every time.

SOLUTION: We used our traditional box-screw method which will allow for a quick connect/disconnect but also will add needed strength to the wings.



**After testing, troubleshooting and a driving practice,
We are now ready to compete with our new robot.**

Wildcats VRC Over Under Qualifier @ RCDS

Today's Goals:

1) Test New Robot
2) Get to Finals - and win tournament
3) Increase Skills Score
4) Impress judges during our interview with our engineering process, knowledge and teamwork

Who was here:

- Matt
- John
- Lazaro

January 20, 2024 We competed In the Wildcats Over Under Qualifier at Rye Country Day.

We achieved our goal today.

1) **We tested the new robot**
2) **We increased our Skills Score**
3) **We became Tournament Champions!**
4) **We won the Excellence Award!**

The Excellence Award recognizes overall excellence in both the Judged Award and the Performance Award categories. The Excellence Award incorporates all the criteria of the Design Award, plus the added component of a team's on-field performance at the event. The Excellence Award is a required award if judging is being conducted at an event..

Wildcats VRC Over Under Qualifier @ RCDS

This was a good day to test our new robot. It competed really well. We went undefeated 5-0 and were ranked 1 in the qualifiers. We picked 78792E as our alliance partner and won the tournament.

LESSONS LEARNED

Base is very good. Didn't get stuck on a bar. Able to hang quickly and consistently.

While we won the tournament with our current robot, we still want to continue to raise the bar. The robot may have performed very well as we continue to play the game and as the meta changes we think of more things we want our robot to achieve to be even more competitive.

1) Higher tier hang or hang on vertical bar

2) Modular component for kicker to use based on alliance partner capability (INNOVATION)

3) Wings vertical and horizontal

Wildcats VRC Over Under Qualifier @ RCDS

Qualifier #3	Jan 20th at 10:42 AM	78792T	19396A	57	16099C	**97140A**	182
Qualifier #7	Jan 20th at 11:27 AM	**97140A**	16099A	91	78792E	25565B	42
Qualifier #11	Jan 20th at 12:08 PM	16099B	97140C	79	90058A	**97140A**	92
Qualifier #19	Jan 20th at 2:26 PM	**97140A**	25565A	142	78792T	9717B	62
Qualifier #26	Jan 20th at 3:52 PM	6277B	**97140A**	102	97140B	9717A	23
Qualifier #30	Jan 20th at 2:52 PM	9458C	18693A	0	18693C	**97140A**	0
QF #1-1	Jan 20th at 4:54 PM	**97140A**	78792E	200	9717A	90058A	54
SF #1-1	Jan 20th at 5:33 PM	**97140A**	78792E	145	78792T	16099B	45
Final #1-1	Jan 20th at 6:02 PM	**97140A**	78792E	98	16099C	16099A	65

Wildcats VRC Over Under Qualifier @ RCDS

Award	Team #	Team Name	Affiliation	Location
Excellence Award (VRC/VEXU/VAIRC)	97140A	Kennedy Gaels	Kennedy Catholic Preparatory School	Somers, New York, United States
Tournament Champions (VRC/VEXU/VAIRC)	97140A	Kennedy Gaels	Kennedy Catholic Preparatory School	Somers, New York, United States
Tournament Champions (VRC/VEXU/VAIRC)	78792E	MARS	The Mount Academy	Esopus, New York, United States
Design Award (VRC/VEXU/VAIRC)	6277B	Loose Screws	THE HARVEY SCHOOL	Katonah, New York, United States
Robot Skills Champion (VRC/VEXU/VAIRC)	78792E	MARS	The Mount Academy	Esopus, New York, United States
Judges Award (VRC/VEXU/VAIC/ADC/VAIRC)	9717A	St. Catharine Comets	ST CATHARINE ACADEMY	Bronx, New York, United States
Sportsmanship Award (VRC/VEXU/VAIRC)	18693B	Wildcats	RYE COUNTRY DAY SCHOOL	Rye, New York, United States

New Robot - Robot Number 3 - Base and Mass Reduction

January 21, 2024 We started design on a new robot - ROBOT NUMBER 3 - for the season.

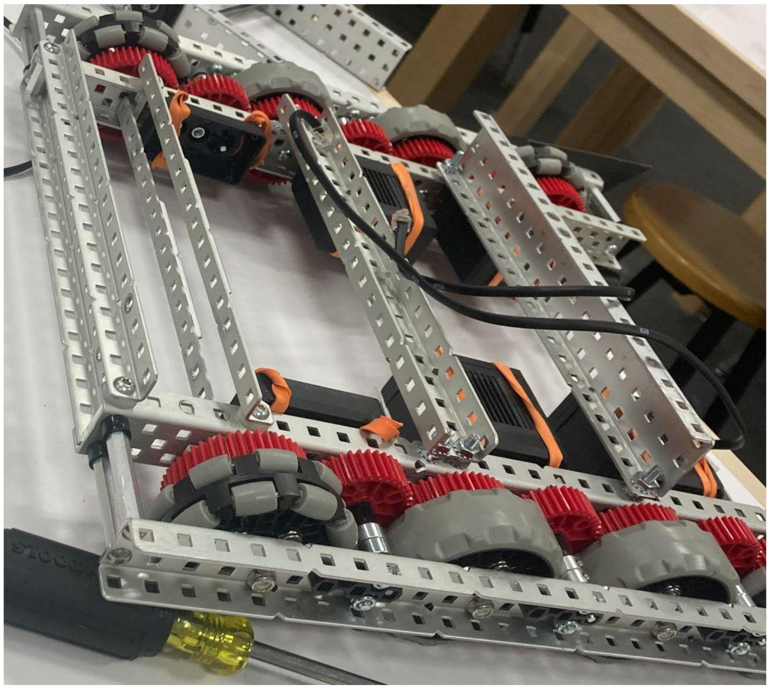
Today's Goals:

1) Build new base with black powder coated metal and black dyed gears
2) Analyze how the game strategies and meta changed over time
3) Define and brainstorm on what mechanisms will give us a winning advantage

Who was here:

- Matt
- John
- Lazaro

Time and date: Jan 21, 2024 - 12:00pm-4:00pm



We always start our build with a standard question: "*Matt, what would you like to drive next*?"

Analyzing our past experience and factoring in driver wishes and game winning strategies, we agreed that our previous drive base was close to perfect.

New robot will be all black. We will compete at States in style.

But how do you improve on a robot that performs to well?

One area that is always on every builder's mind is how to make the robot as light as possible without sacrificing performance, structural integrity and competitive advantage.

New Robot - Robot Number 3 - Base and Mass Reduction

There are some pretty basic rules we always try to follow when we build our robots, like don't use screws longer than necessary. This sounds silly but in large quantities (and we do use large quantities of screws) that extra steel ads up.

Why is mass important this season?

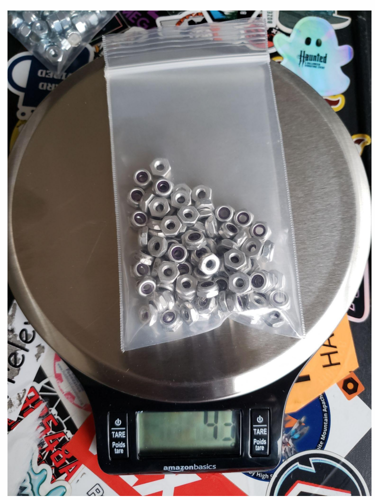
- Elevation. The heavier the robot the harder to build a mechanism that pulls robot up;
- Barrier. Jumping over the barrier is hard for heavy robots as they get stuck;
- Speed. Heavy robots need a lot more torque to move that mass which results in clunky slow robots with overheating motors.

We decided to look into using lighter screws since this season the GDC is allowing us to use non-steel screws and nuts once again (this was banned last season). Our past attempts at using nylon screws and aluminum screws all failed because the nylon screws snap and fall off and the aluminum screws just break under heavy load.

That led us to aluminum nuts used together with traditional stainless steel screws.

But will that make an impact at all? One way to find out.

We compared a bag of 70 standard official VEX nuts with a bag of 70 low profile aluminum nuts.



The steel nuts weigh 173 grams. The aluminum nuts weigh 43 grams.

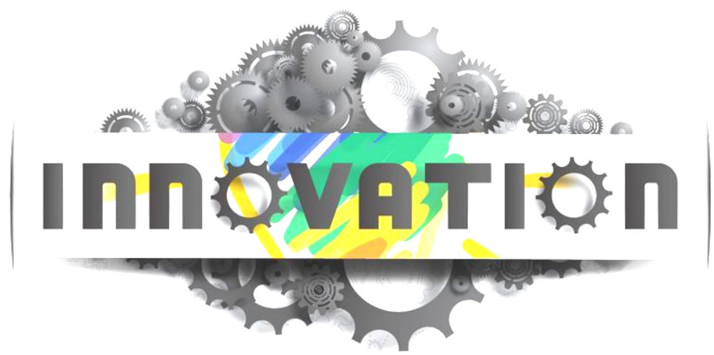
New Robot - Robot Number 3 - Base and Mass Reduction

The steel nuts weigh 173 grams. The aluminum nuts weigh 43 grams.

That is a 130 grams savings. We estimate that we usually use double the amount of nuts, so we can remove over 250 grams just by doing this one little change. That's about half a pound which is substantial.

While using lighter nuts is not revolutionary and has been done by teams in the past, we believe that this next method we came up with to mount bearing flats onto a channel is innovative.

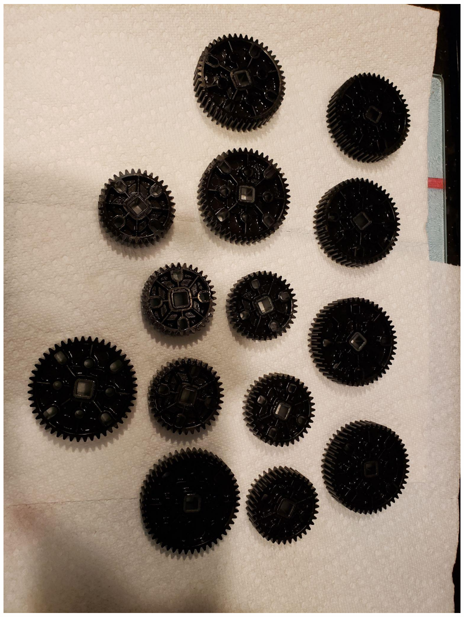
Traditionally, a bearing flat is mounted like this, with 2x ½ inch screws:



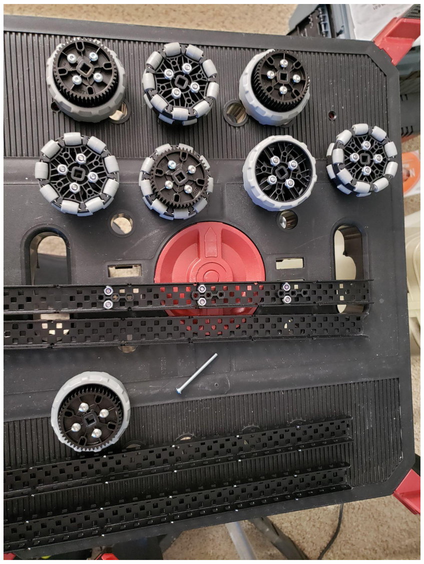
We found a better way, which also reduces mass in the process by using much shorter (¼ inch) screws. Another bonus, assembly is flatter and allows for more stuff to be mounted around. In the traditional way, the screw and the nut always interfere with mounting other parts around that bearing.

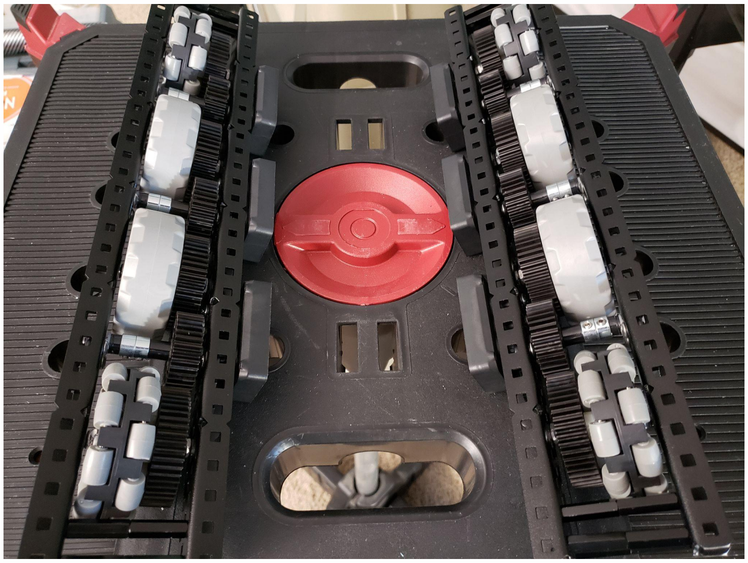
New Robot - Robot Number 3 - Base and Mass Reduction

Since we planned to have a black robot for States for quite a while, we had dyed all the necessary gears in advance.



Time to build our traditional Kenny wheels (named after our Spin Up robot which had wheel-gear sandwich assemblies before VEX started selling wheels with matching holes.



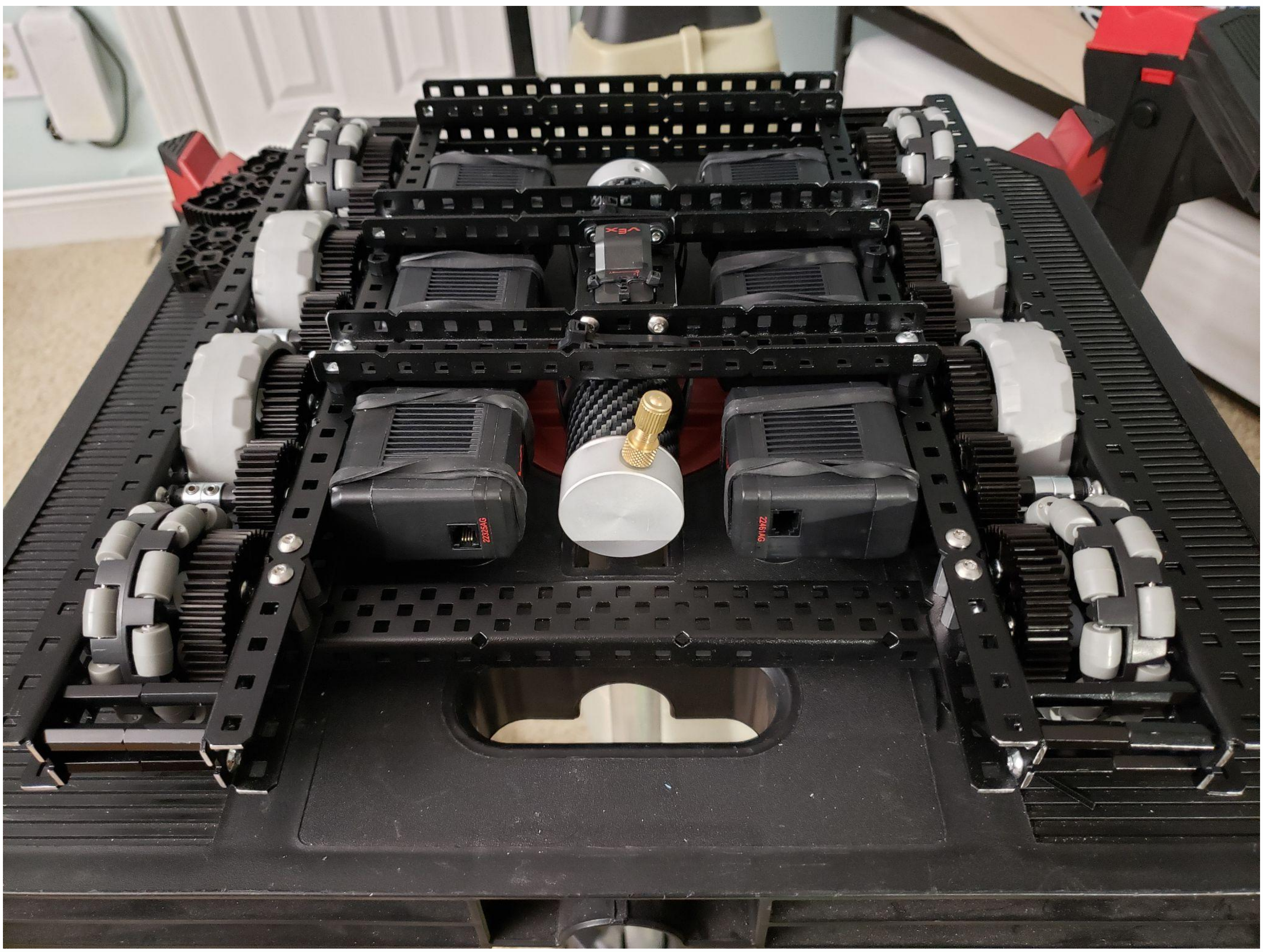


New Robot - Robot Number 3 - Base and Mass Reduction

One last minute change before we put together the chassis (base): Matt decided that the base should be an inch narrower based on his driving experience accumulated from previous tournaments. He explained that a narrow base makes it easier to zip around the field, evade pins and traps and is less likely to get stuck in the tunnels (which is what we call the 2 “under” areas of the game where a lot of large robots get stuck.

After a few important cosmetic improvements, such as wrapping the air reservoir in carbon fiber wrap, we finally had a fully assembled ALL BLACK base.

We compete on Saturday and are not ready to use Robot Number 3 so we will use Robot Number 2.



Kennedy Bellmore Robotics Competition Over Under

Today's Goals:

1) Get to Finals - and win tournament
2) Increase Skills Score
3) Impress judges during our interview with our engineering process, knowledge and teamwork

Who was here:

- Matt
- John
- Lazaro
- Brenna

January 27, 2024 We competed in the Kennedy Bellmore Robotics Competition Over Under. We did not finish Robot Number 3 so we competed with Robot Number 2.

We achieved part of our goal today.

1) **We increased our Skills Score -** Ranked 3rd. 302 Score: 173 driver score and 129 auto
2) **We won the Think Award!**

Think Award; The Think Award recognizes the most effective and consistent use of coding techniques and programming design solutions to solve the game challenge.

Key criteria of the Think Award are:

- Autonomous programming is consistent and reliable.
- Programs are cleanly written, well commented, and easy to follow.
- Team clearly explains the programming strategy to solve the game challenge.
- Team clearly explains their programming management process/version control.
- Students understand and explain how they worked together to develop their robot programming.
- Team interview demonstrates effective communication skills, teamwork, professionalism, and a student-centered ethos.

Kennedy Bellmore Robotics Competition Over Under

Kennedy Robotics Competition Over Under

Qualifier #5	Jan 27th at 10:28 AM	**97140A**	59968H	72	1808A	1808C	35
Qualifier #15	Jan 27th at 11:19 AM	59968J	62880B	39	77628A	**97140A**	120
Qualifier #24	Jan 27th at 1:11 PM	**97140A**	97140B	90	11442Y	24842T	61
Qualifier #36	Jan 27th at 2:08 PM	59968M	49627A	47	11570B	**97140A**	100
Qualifier #40	Jan 27th at 2:26 PM	6277B	59968F	88	59968P	**97140A**	93
Qualifier #55	Jan 27th at 3:38 PM	41579B	**97140A**	142	8880A	11566B	36
QF #2-1	Jan 27th at 5:43 PM	**97140A**	6277B	126	77628A	59968J	0
SF #1-1	Jan 27th at 6:08 PM	62880A	59968H	76	**97140A**	6277B	0
R16 #3-1	Jan 27th at 4:54 PM	**97140A**	6277B	135	8880B	59968P	18

Rank	4
WP / AP / SP	12 / 12 / 306

We were undefeated and 6-0 in the qualifiers. We were in a good position to win the tournament. We selected team 6277B as our alliance partner. We made it to the semi finals and due to a call from the head referee they determined that our alliance partner interfered with the hang of the red alliance and therefore disqualified. It took over a half hour for the referees to decide that. We spent that time verifying the rules and showing the rules to the referee because we disagreed with the call. Because it was a very close match they eventually determined it was match effecting and we didn't move on.

Name: Matthew Achim
Project Name: Kennedy Bellmore Tournament
Date: 1/27/24
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Clash @ Kennedy Robotics Competition Over Under

Today's Goals:

1) Host a great tournament

Who was here:

- Matt
- John
- Lazaro
- Brenna

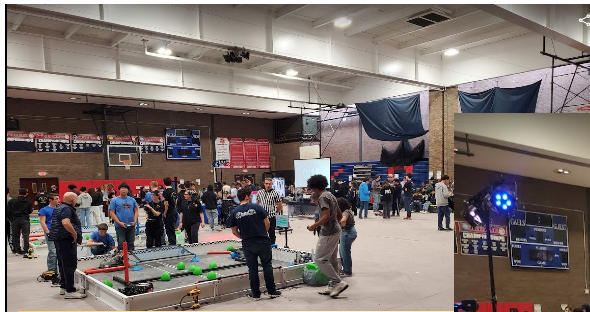
February 10, 2024 We hosted our own tournament Clash @ Kennedy Robotics Competition Over Under.

We achieved our goal today.

1) **We hosted a tournament for 38 teams and it ran smoothly. Teams enjoyed the tournament.**
2) **We won the Think Award!** For the second time this season for the most effective and consistent use of coding techniques and programming design solutions to solve the game challenge.
3) **We were tournament finalists.**

Clash @ Kennedy Robotics Competition Over Under

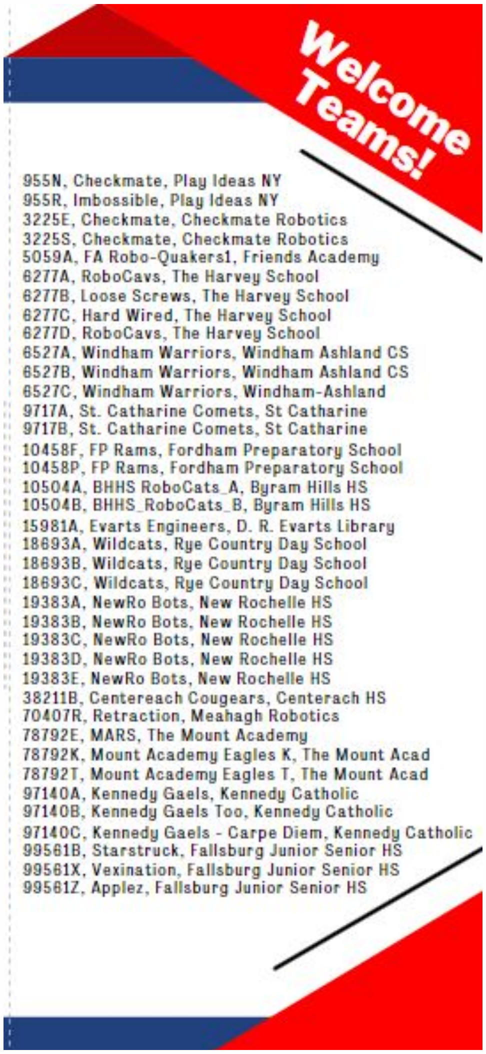
BEFORE SET UP



AFTER

LIVE STREAM

SKILLS



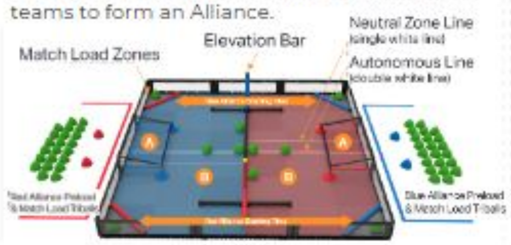
CONCESSION STAND

ROBOSAURUS

How the Game is Played

VEX ROBOTICS COMPETITION OVER UNDER

Two Alliances one "red" and one "blue" - composed of two Teams each compete in a Match. The object of the game is to attain a higher score than the opposing Alliance. Match length is :15 seconds autonomous and 1:45 driver controlled.
During Qualification Matches teams are randomly paired to form an Alliance. During Elimination Matches the Alliances are formed as the higher-ranked teams extend invitations to teams to form an Alliance.



Autonomous Bonus Winner	8 Points
Each Triball Scored in a Goal (A)	5 Points
Each Triball Scored in an Offensive Zone (B)	2 Points
Elevation - Top Tier	20 Points
Elevation - 2nd Tier	15 Points
Elevation - 3rd Tier	10 Points
Elevation - 4th Tier	5 Points

AWARDS

- Excellence Award*: Top All Around Team (Robot Performance and Judged)
- Tournament Champions:* (2 teams) 1st Place Finals Match Alliance (Robot Performance)
- Tournament Finalists: (2 teams) 2nd Place Finals Match Alliance (Robot Performance)
- Design Award*: Team with the most effective and efficient robot design process (Judged)
- Robot Skills Champion*: Team with the highest combined top Programming and top Driving Skills Challenge score (Robot Performance)
- Judges Award: Team deserving recognition from Judges for special accomplishments (Judged)
- Amaze Award: Team with an amazing, well-rounded, and top performing robot
- Think Award: Team with impressive and effective autonomous programming
- Build Award: Team with a well-crafted robot

*winners qualify for State Championship

Thank You

Thank you Father Vaillancourt and the Kennedy Catholic staff for your support.

Thank you to John Wahlers and Chris Kelly from The Harvey School and Eddie Maendel from The Mount Academy for all you do.

Thank you to our volunteers.

CLASH AT KENNEDY

VEX ROBOTICS COMPETITION

Over Under Qualifier

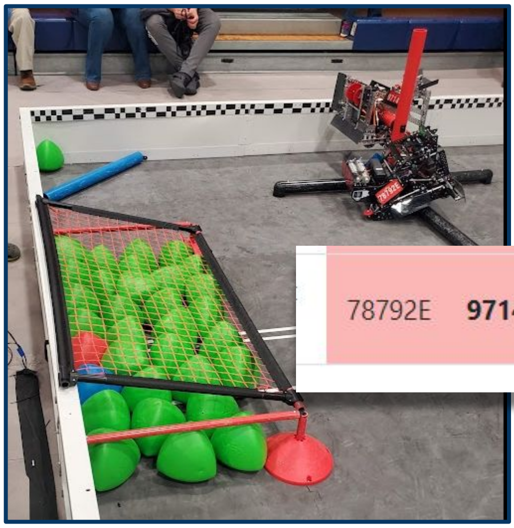
Saturday, February 10, 2024

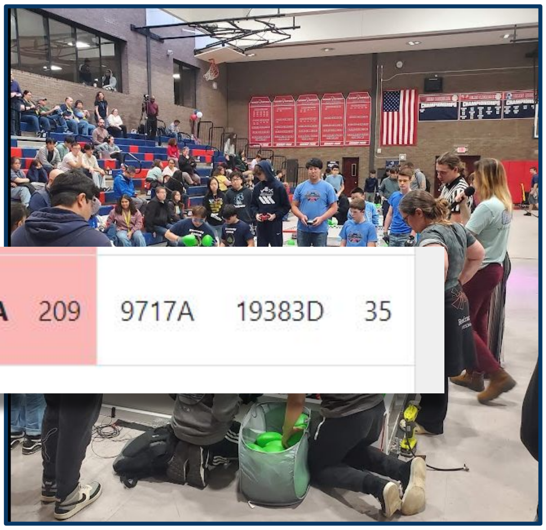
Kennedy Catholic Preparatory School
54 Route 138, Somers, New York 10589
www.kennedycatholic.org
https://linktr.ee/kcrobotics

KEY CHAINS
NECKLACES
EARRINGS

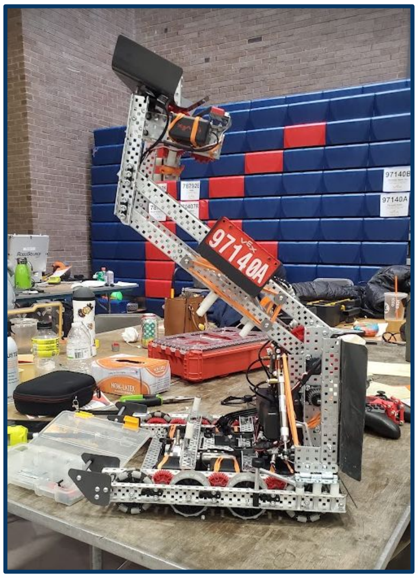
Name: Matthew Achim
Project Name: Clash @ Kennedy
Date: 2/10/24
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

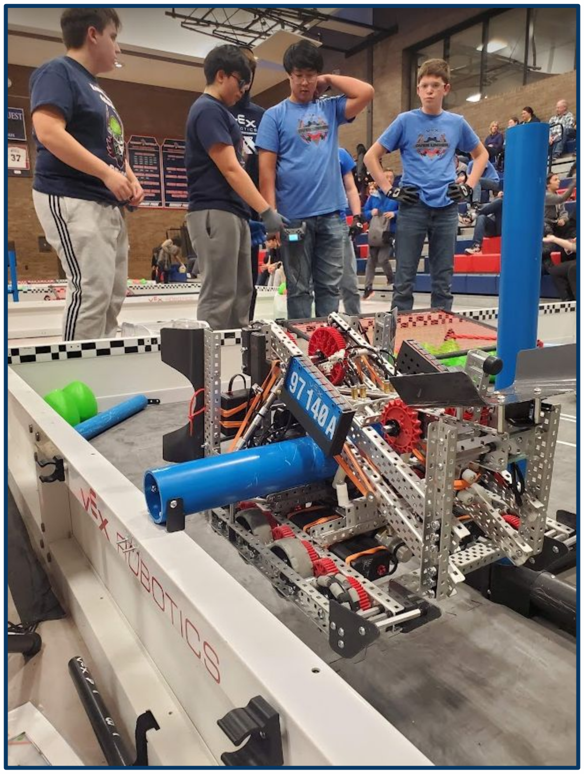
Clash @ Kennedy Robotics Competition Over Under





78792E	**97140A**	209	9717A	19383D	35





New Robot - Robot Number 3 - Intake

Today's Goals:

1) Build intake, test robot and intake
2) Analyze evolution of game strategies
3) Re-write autonomous code
4) Decide whether to use new robot or old robot at next competition

Who was here:

- Matt
- Brenna
- Lazaro

Time and date: 2/14/24

We analyzed the evolution of this season's game strategies by rewatching all the Signature Events semifinals and finals and came to the conclusion that matches that involve high level teams are very low scoring because teams know that if they shoot a bunch of triballs over to the other side, the opponents can easily take those triballs and bring them back to their side.

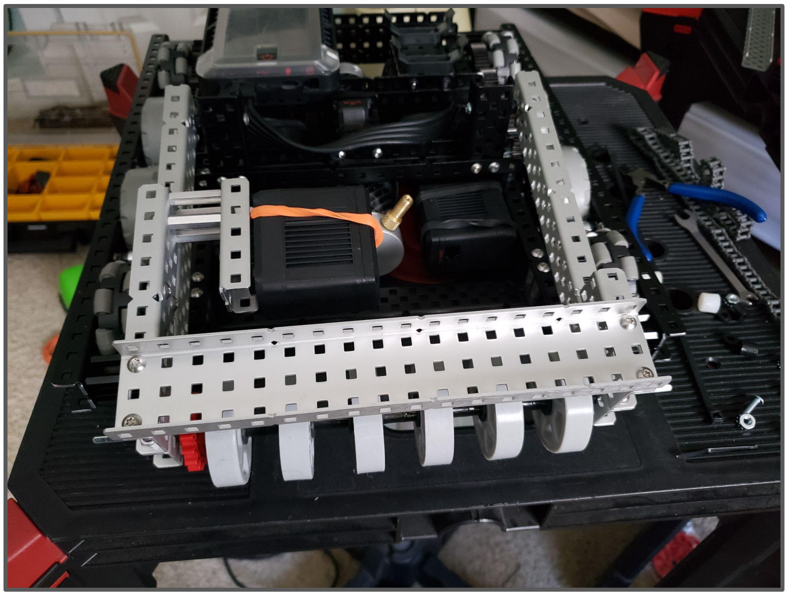
We noticed robots are ditching high arms and blockers in favor of fast robots with effective intakes.

ITERATE ON ROBOT 1 INTAKE

With the new knowledge in mind we quickly prototyped an intake based on flex wheels.

Our Robot No. 1 intake had the classic rubber band roller design and we decided to improve on that and make it even better.

We placed the motor on the inside and used a 6P (skinny) chain transmission hidden inside the metal frame for protection.

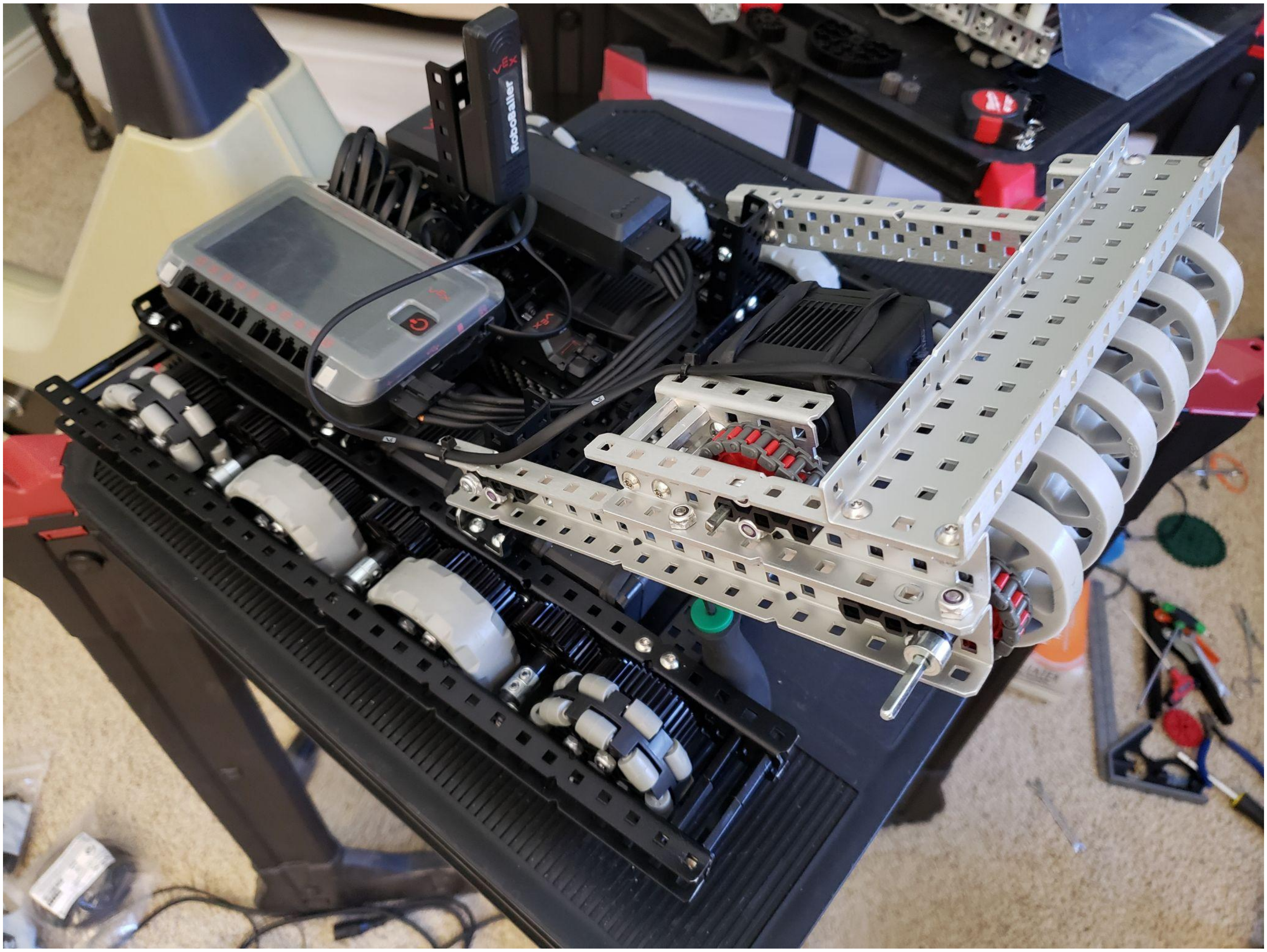


New Robot - Robot Number 3 - Intake

We very quickly finer tuned our intake and smoothened some rough edges (literally! With a file…) then spent the rest of the day testing and fine tuning some more.

We all took a vote and decided this new robot is worthy to be tested in a real competition as is. We added one very quick air cylinder with a short c-channel on to the right side of the robot for a hang and re-wrote our match autonomous to utilize the intake.

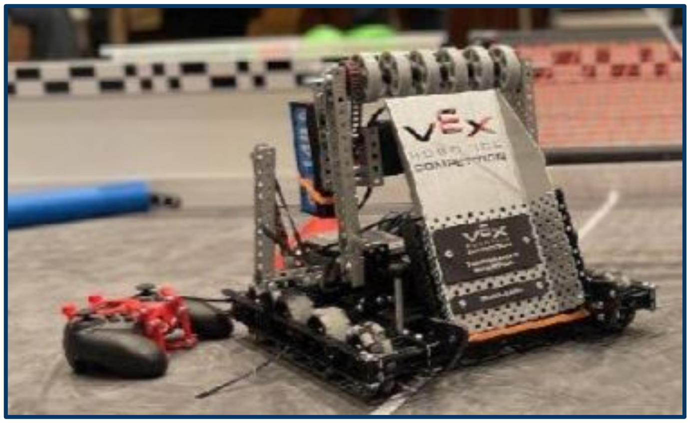
This robot is ready for its first battle!



Adelphi University Over-Under Qualifier

Today's Goals:

1) Test out the new robot.
2) Get to Finals - and win tournament
3) Impress judges during our interview with our engineering process, knowledge and teamwork



Who was here:

- Matt
- John
- Lazaro

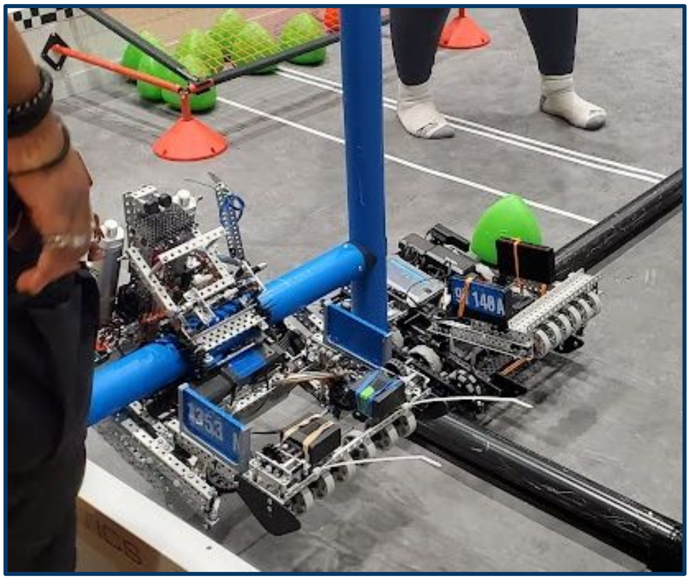
February 17, 2024 we went to Garden City, Long Island to attend Adelphi University Over-Under Qualifier tournament.

We achieved our goal today.

1) **We tested our new robot.**
2) **We won Tournament Champions!**

Adelphi University Over-Under Qualifier

We still have not completed Robot Number 3 but we felt it was ready for testing at the Adelphi tournament so we could have more ideas of what we should improve before we compete at States. It was faster than the last two robots. It was easier to drive.



Name: Matthew Achim
Project Name: Adelphi University Tournament
Date: 2/17/24
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

New Robot - Robot Number 3 - Intake Iteration

Today's Goals:

1) Apply what we learned at last competition
2) Iterate intake and finalize in black
3) Plan the remaining of the build

Who was here:

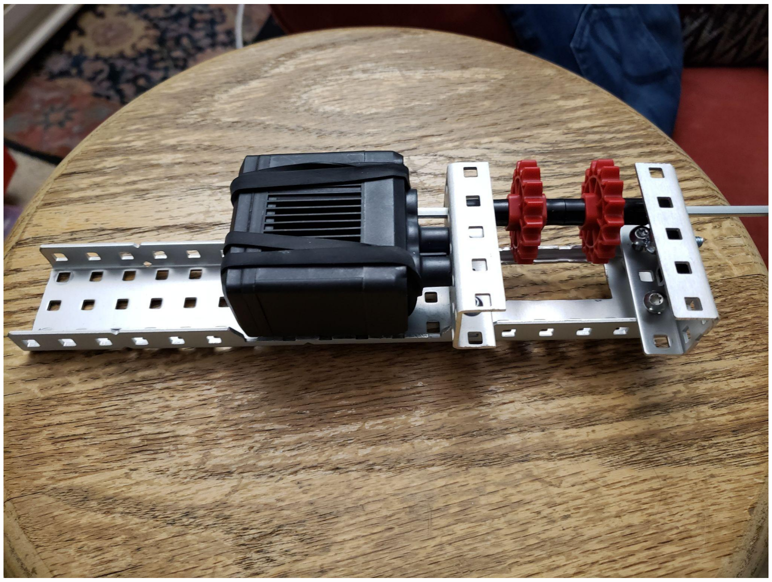
- Matt
- Lazaro

Time and date: **2/18/24 10am-12pm**

One major redesign for the intake was decided after our winning performance at Adelphi:

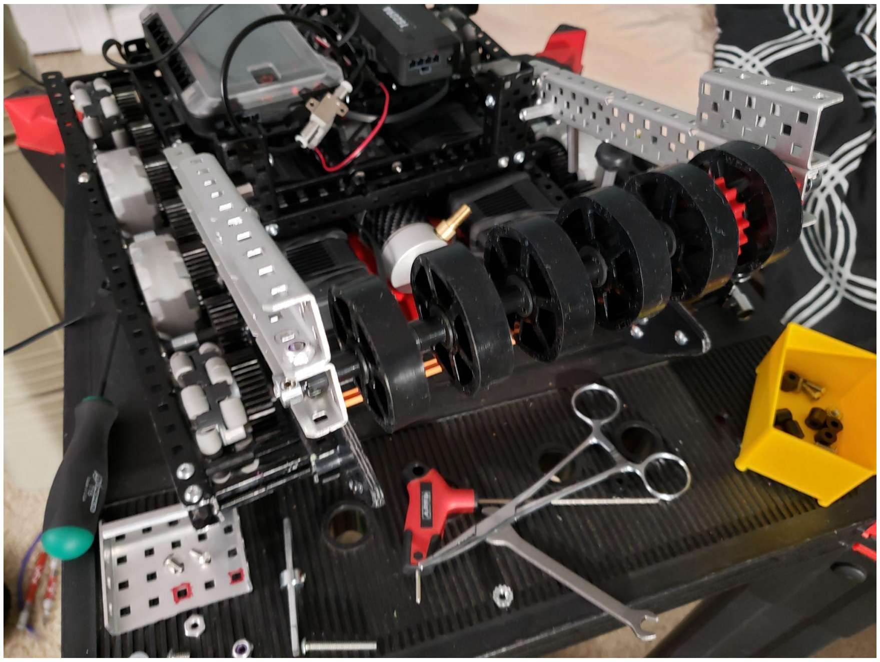
We will keep our commitment to make this the lightest robot we have ever built so we will not use a heavy air tank onto the top of our intake as it seems the majority of the meta teams are doing. Instead we will place our motor on the very top. This way, mass is shifted to the tip of the robot. While not as heavy as an air tank, a V5 11W motor has a significant contribution to mass tipping.

A second advantage to this is that there will be room now to front load triballs as we open a big gap and also the intake grips the triballs better.



New Robot - Robot Number 3 - Intake Iteration

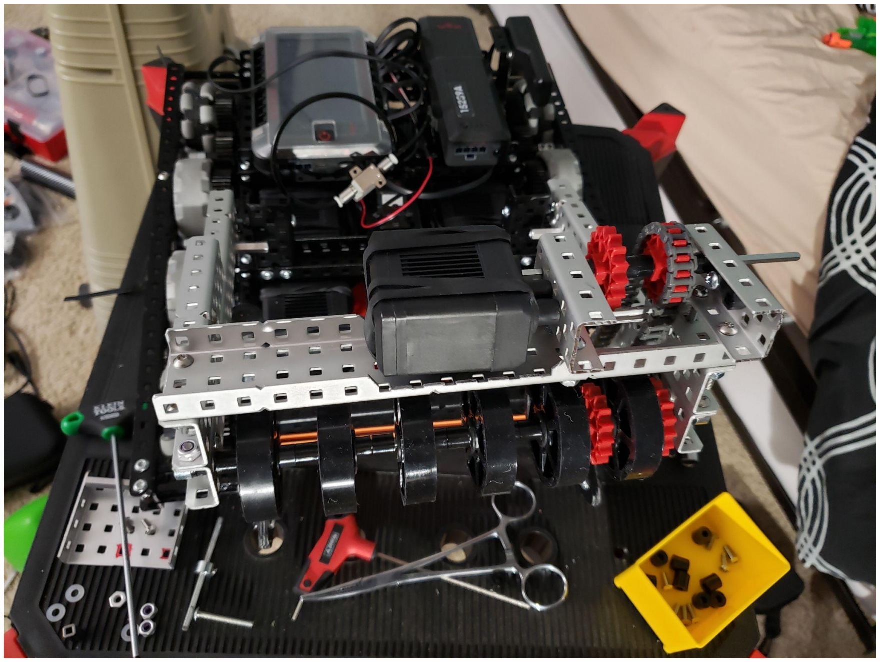
For the rollers, we used black 2” Flex Wheels with a Durometer of 30A. We tested all three legal VEX Durometers (30A 45A and 60A) and determined that the softer wheels grip best.



For our black theme we were able to buy competition legal 30A wheels in black from WestCoast Products (https://wcproducts.com/products/wcp-1284)

SInce we don’t have enough black powder coated metal left and can’t afford to waste any, we prototyped our final intake using regular silver metal first.

A few iterations were done on the top part where the chains are mounted. From past experiences, chains snap very easily.



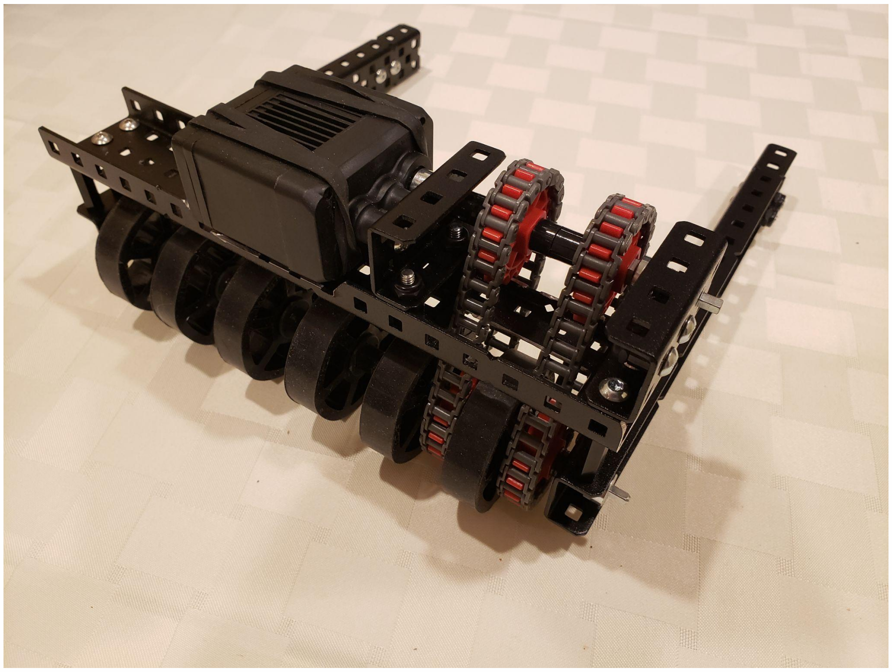
To create as much redundancy as possible we used a double set of sprockets. If one chain breaks, the second one will still move the rollers.

We also made a metal cage to fully enclose the chain mechanism and protect from impact.

New Robot - Robot Number 3 - Intake Iteration

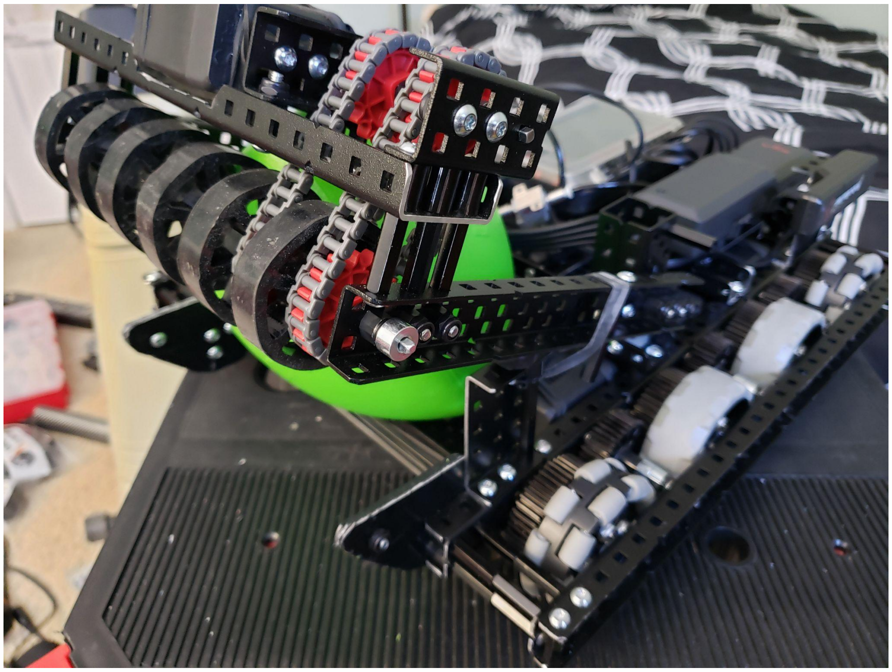
After some minor iterations we decided to go ahead and build the final intake subsystem in black and put the final finishing touches.

We are quite proud of the final iteration. It looks and performs great!



We mounted onto our black chassis and spent the rest of the meeting testing, driving, testing and then testing and driving some more.

It was a great meeting today.We built something awesome and the fact that it performed better than we expected made us very proud and very happy.



New Robot - Robot Number 3 - Air Cylinder Adjustable Links

Today's Goals:

1) Figure out a better way to mount pneumatic air cylinders onto robot.

Who was here:

- Matt
- Lazaro

Time and date: 2/21/24

Problem:

To be successful in making good wings, whether vertical or horizontal, it is critical to get all the sizes right as it affects how much wings open and how they fold. We can adjust many things such as location of hinges etc. However, the air cylinders we can legally use in competitions come with very specific stroke size (the distance between when piston retracted and piston fully extended) and the only adjustment to that comes as a small amount of thread on the tip of the piston rod. In the past seasons VEX sold air cylinders that came with little steel brackets that offered some mounting options. See below.

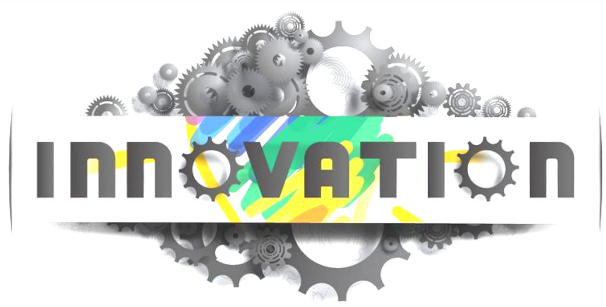
One of the critical requirements for making hinged wings is that the air cylinder pivots at each end.

For our final robot we will be using the New Official V5 Pneumatics Kit released by VEX. The air cylinders that come with this kit no longer include brackets (see right) and we tried different methods in the past but were not happy with the results.

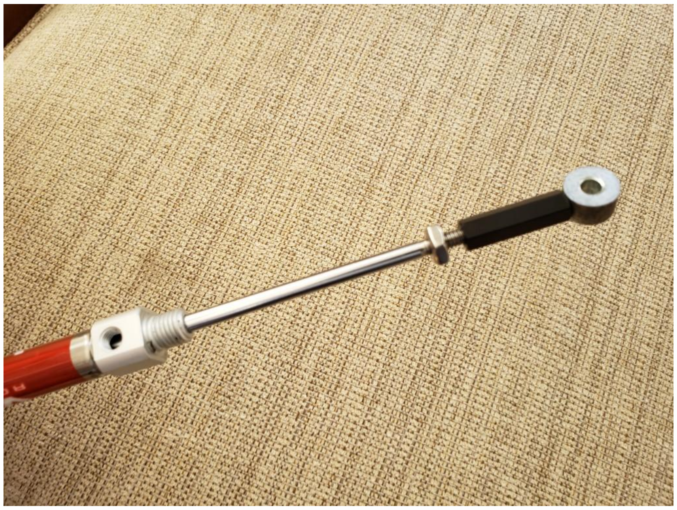
New Robot - Robot Number 3 - Air Cylinder Adjustable Links

Our Original Solution:

Since Matt loves to work on cars he mentioned that a lot of a car's suspension gets adjusted with tie rods and threaded links. He also remembered from working on RC cars that he used these little plastic links that would thread onto the axle and by turning them in or out, he could adjust camber and steering that way. Similar to these adjustable BMW sway bar ends:



The new air cylinders from the new VEX kit come with an 8-32 thread compatible with the rest of our parts (the old ones had a different thread). We experimented with hex standoffs, shaft collars and other parts and came up with a great solution: An adjustable end link that fits onto a piston rod and gives us a nice pivoting link and also a generous amount of adjustability:



New Robot - Robot Number 3 - Kicker - Swappable Subsystem 3

Create a true modular quick-swappable subsystem 3

Today's Goals:

1) Build kicker
2) Mount kicker
3) Test kicker

Who was here:

- Matt
- Lazaro

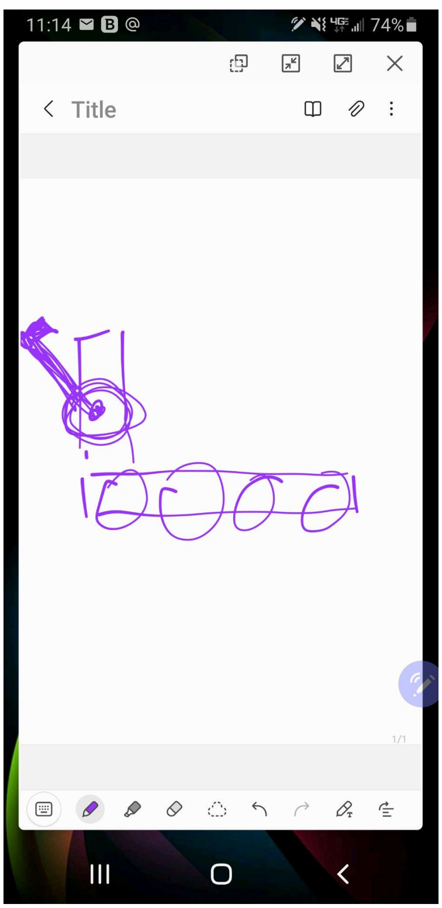
Time and date: 2/25/24 10am-4pm

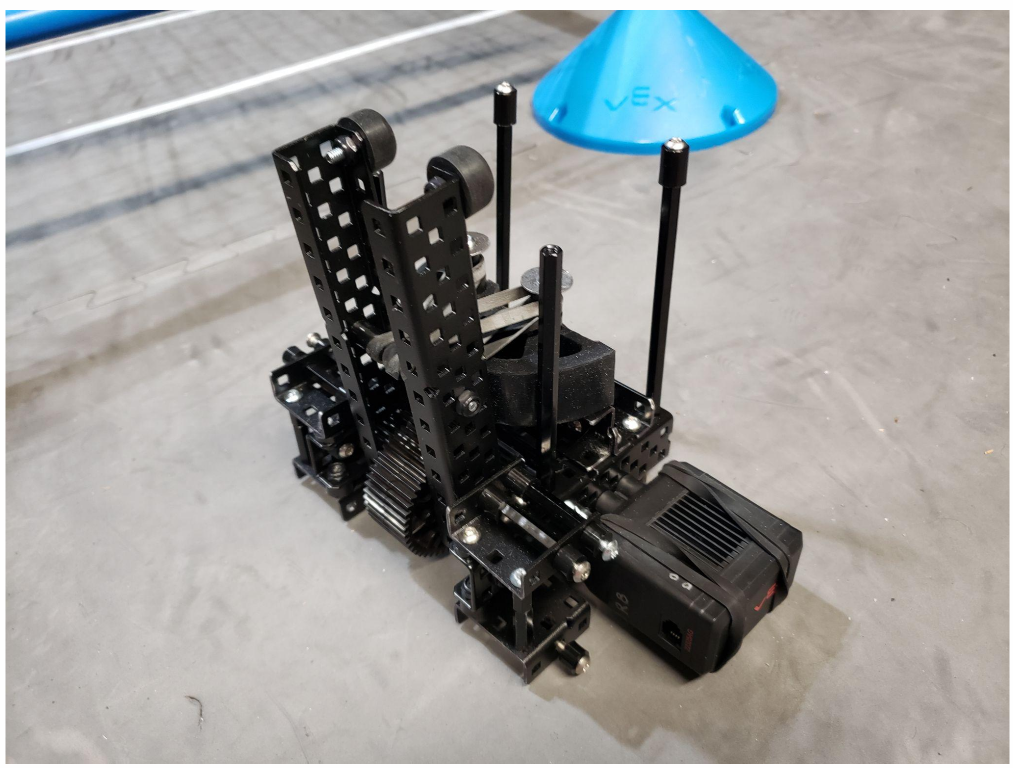
Our team does not have any doubts or divides regarding flywheel vs kicker vs slapper vs catapult vs puncher. We are and have been team kicker from the very beginning after our original discussions and decision matrix.

We took inspiration from our previous kicker that was very successful and iterated based on the new size constraints and new positioning.

We moved the location of the arm, rubber bands and motor accordingly.

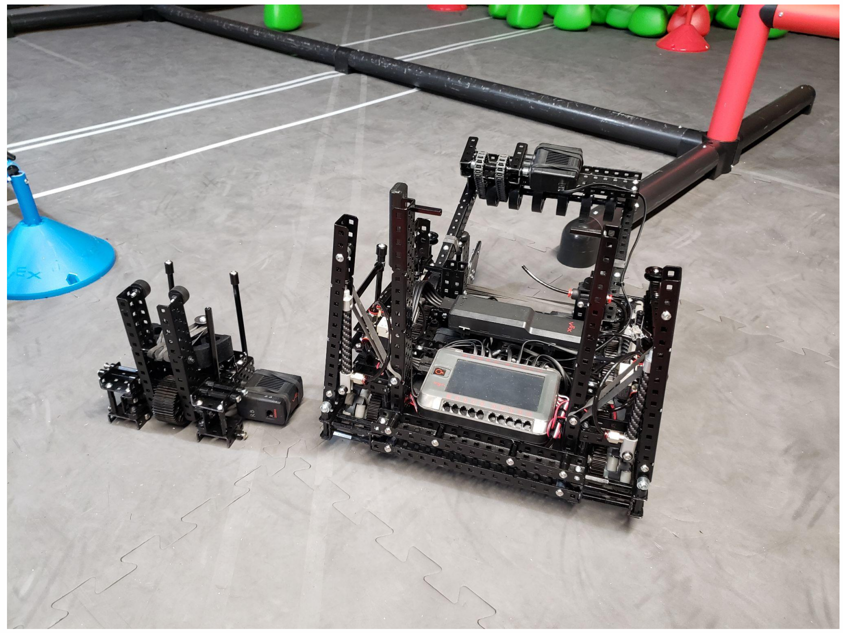
From a simple sketch to a black shiny subsystem 3:





New Robot - Robot Number 3 - Kicker - Swappable Subsystem 3

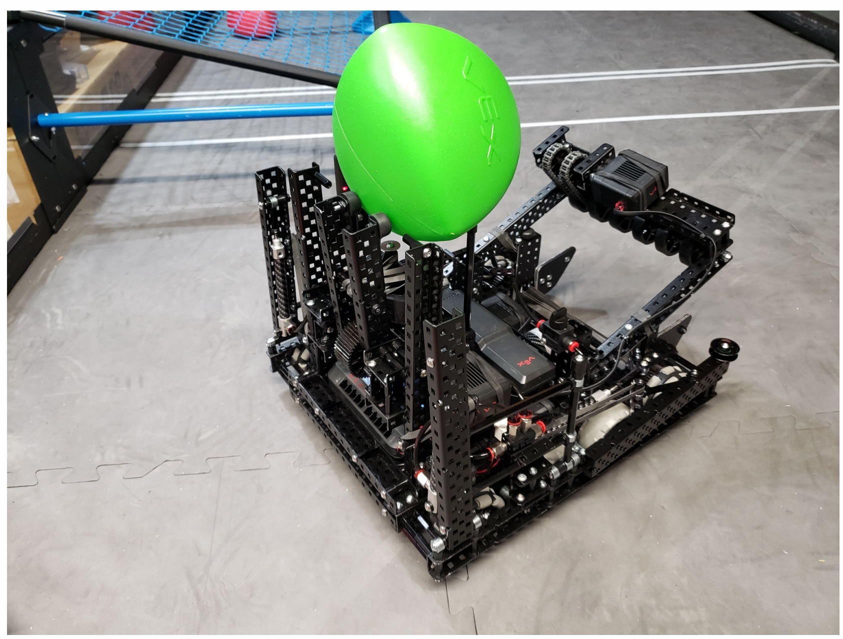
Create a true modular quick-swappable subsystem 3



We are now very few steps away from achieving our big goal of a truly modular robot with hot swappable subsystem 3 mechanisms.

Module is fitted to be mounted onto our universal chassis.

In this configuration, we will mostly use the robot for Skills as in Skills a launching mechanism is one of the major factors needed to succeed in getting a high score.



Our module mates perfectly to the base and the connection is very solid.

It is imperative that nothing bends or self-destructs in case the kicker is dry fired so we started an extensive test regimen.

In the process of testing, we made the usual adjustments to get the best trajectory possible: amount of rubber bands, position and angle of triball rest.

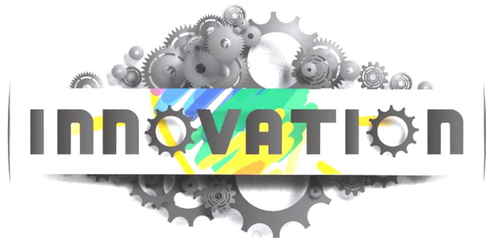
New Robot - Robot Number 3 - Kicker - Swappable Subsystem 3

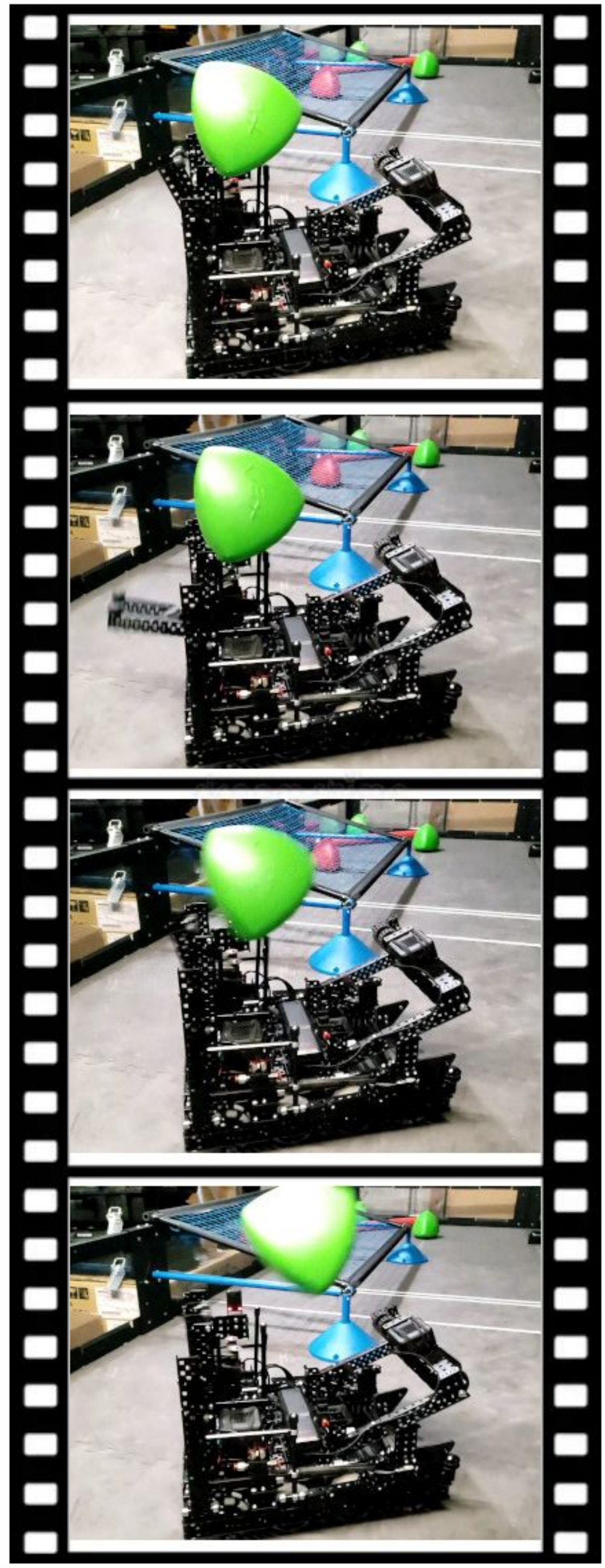
Create a true modular quick-swappable subsystem 3

As Matt has done since the days he competed as RoboBaller in the SpinUp season, we used the power and advantage of a super important tool that allows us to literally see everything that happens during a kick:

The slo-mo video.

We spent the rest of our session testing the kicker, filming more slo-mo and analyzing the frames. We iterated quite a bit on rubber bands and position of triball and when we got it to what we considered perfection, we realized we much exceeded the time for cleanup and go home.





New Robot - Robot Number 3 - Elevation Arm - Swappable Subsystem 3

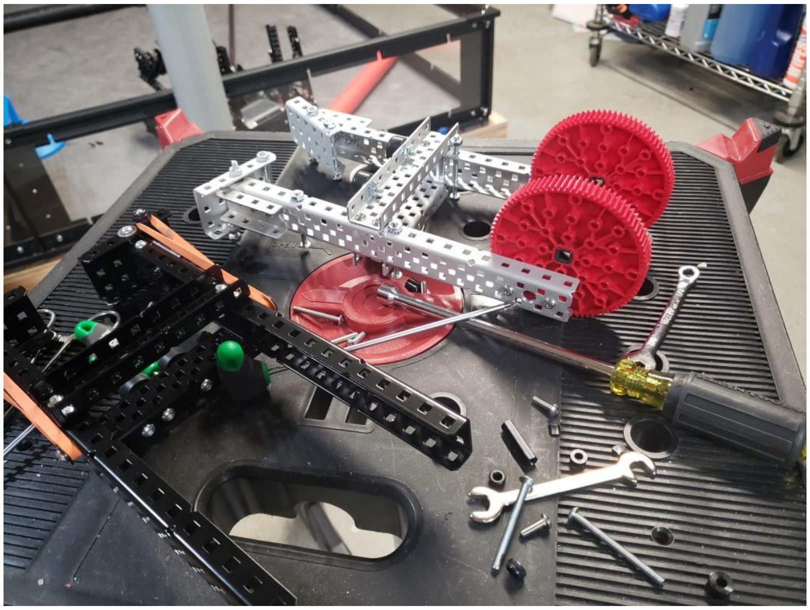
Today's Goals:

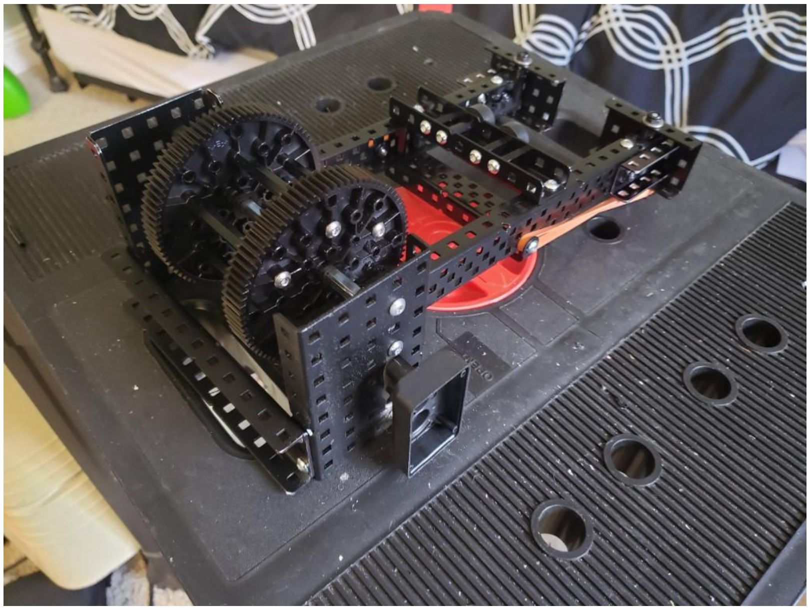
1) Build elevation arm
2) Mount as subsystem 3
3) Finalize build

Who was here:

- Matt
- Lazaro
- John

Time and date: 2/27/24

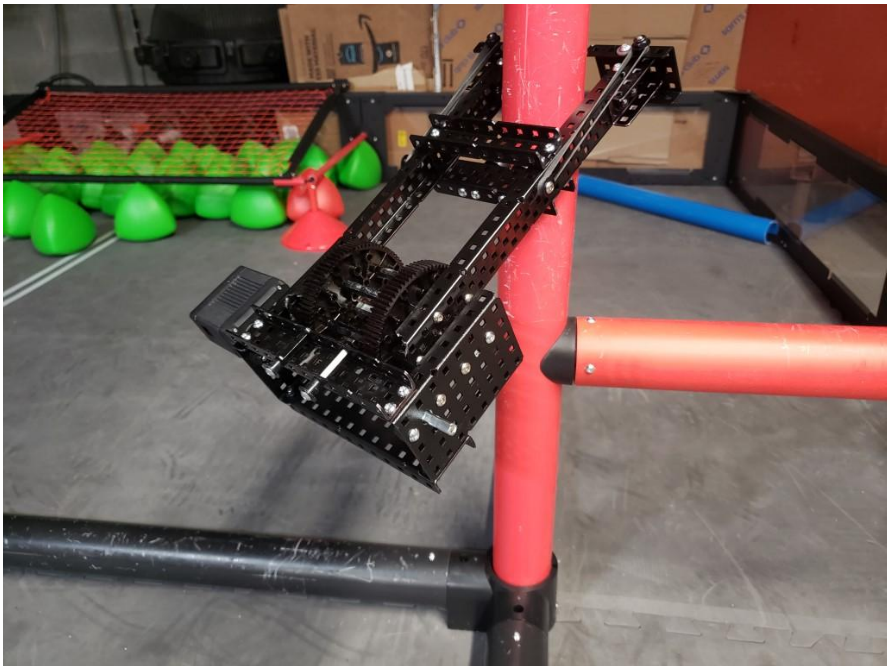




We started with a process that became standard for us this season:

- Make a sketch
- Prototype in silver
- Iterate
- Finalize
- Build final in black
- Test
- Refine
- Test again
- Refine
- Test again
- Compete

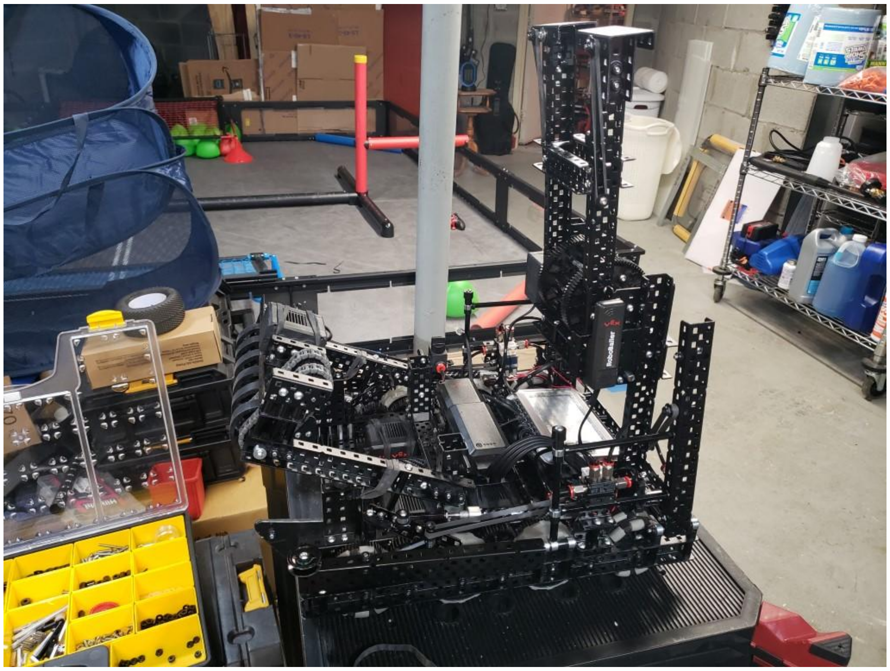
New Robot - Robot Number 3 - Elevation Arm - Swappable Subsystem 3



Modular arm seems to work as designed.

We tried different grips like rubber stoppers, rubber mat, bare metal, etc.

Time to mount onto robot and do real testing.



Arm fit perfectly and we have a quick swap solution with 6-8 screws that holds perfectly.

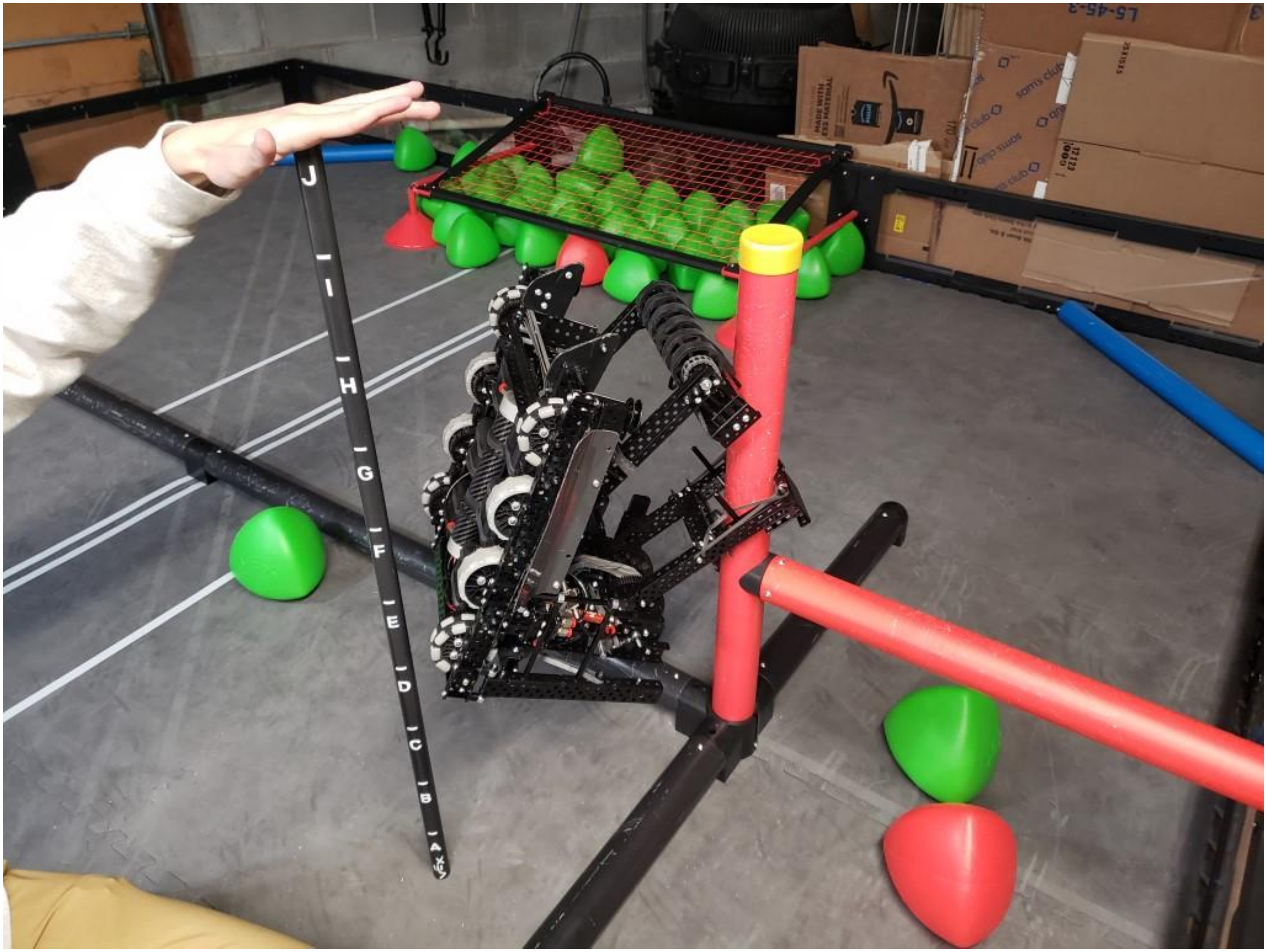
Nothing bends, the arm can hold our robot.

We were able to build the lightest robot ever in our entire VEX history.

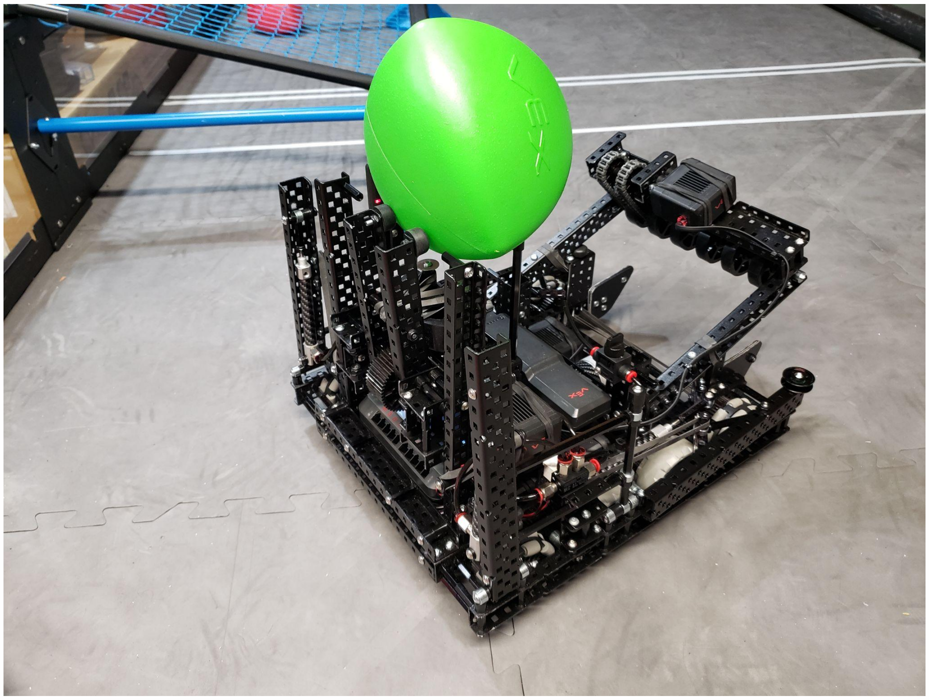
New Robot - Robot Number 3 - Elevation Arm - Swappable Subsystem 3

While chasing the coveted D Tier hang, we spent the rest of our meeting testing, iterating, fine tuning. One major change was the decision to switch from using rubber bands to surgical tubing. By using the tubing we finally got that balance between the motor lifting the arm and the arm pulling back the entire mass of the robot.

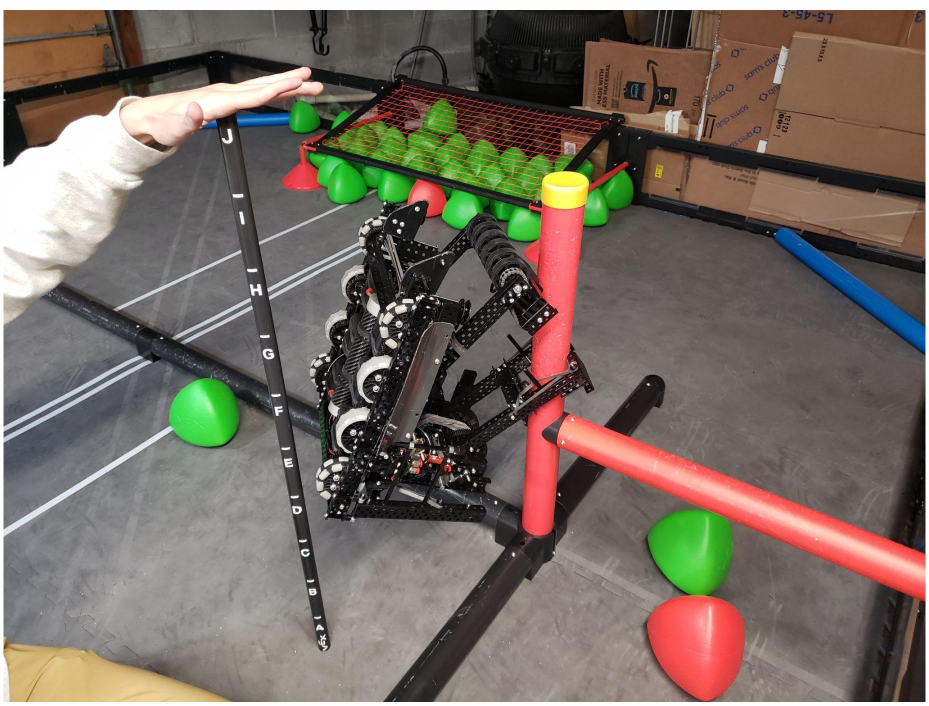
We had to take breaks to allow the motor to cool down. This is difficult to achieve with one single 11 Watts motor but we have done it!



New Robot - Robot Number 3 - Modular Subsystem 3

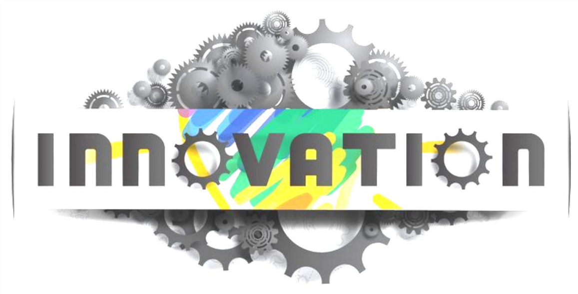


Robot with Kicker Subsystem 3 Used for Skills.



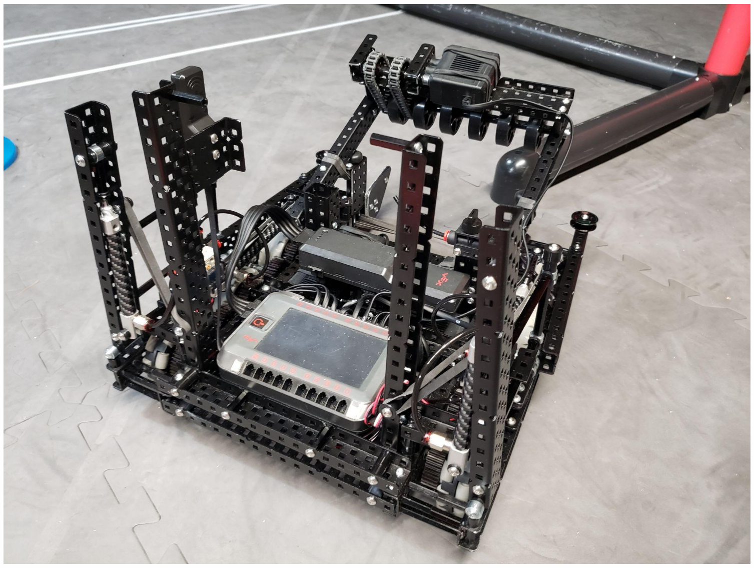
Robot with Elevation Arm Subsystem 3 Used for Matches.

New Robot - Robot Number 3 - Modular Subsystem 3



We believe that we achieved and maybe exceeded all our long term goals:

1. Build a robot capable of taking us to Worlds
2. Create a true modular quick-swappable subsystem 3
3. Make a unique robot (obviously inspired by many other great teams and following the evolution of the game itself over the season, yet not a clone-bot but our very own design and build)
4. Iterate and innovate.
5. Do all of the above in black style while learning and having fun
6. “Go To States; Win States; Go To Worlds; Win Worlds” (WIP)



Robot with no subsystem 3

Our two subsystem 3 modules

Budget Tracker

2023-2024

VEX ROBOTICS COMPETITION OVER UNDER

Name: Matthew Achim
Project Name: Budget Tracker
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Budget Tracker

**Budget - 2023 Costs
(April-Sept 2023)**

Receipt Code	Date	VEX Supplies, Tournament Registrations, Tournament Hosting	Total
v01	4/19/2023	VRC 2023 - 2024 Full Field & Game Element Kit (NOTE only 1 of 2 sets expensed)	**$731.97**
v02	4/30/2023	New 5.5W motors (different from 11W V5) x 10 (3.3/team)	**$353.10**
v03	5/2/2023	Antistatic field tiles x4 to replace foam tiles broken during prev. season	**$104.45**
v04	9/11/2023	Chassis parts for 3 teams (4" wheels, 16 drive motors - 5.3/team out of 8)	**$1,151.48**
v05	9/11/2023	Rolling project carts for 2 teams to comply with new STEM lab space	**$227.54**
v06	9/12/2023	HS v2 gears for chassis for 3 teams (12T;24T;48T;72T;84T - 60T;32T Out Of Stock)	**$293.88**
v07	9/13/2023	Chassis steel drive shafts for 3 teams	**$73.86**
v08	9/13/2023	Hardware 3 teams (screws of various sizes, hex standoffs - we recycle rest from old projects)	**$300.73**
t01	8/31/2023	2023-2024 season teams 97140A; 97140B registration (200; 150)	**$360.50**
t02	9/13/2023	2023-2024 season team 97140C registration (150)	**$154.50**
e01	9/8/2023	2 out of minimum 5 needed to run event (saving 5x$900 on fields that will be borrowed)	**$1,429.12**
t03	9/20/2023	Wildcats VRC Over Under Qualifier @ RCDS teams 97140A, B, C	**$231.75**
			$5,412.88

Name: Matthew Achim
Project Name: Budget Tracker
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

Budget Tracker

Budget - 2023 Costs (October 2023)

Receipt Code	Date	VEX Supplies, Tournament Registrations, Tournament Hosting	Total
v01	10/01/23	4x CMOS battery for donated DELL laptops for teams ABC	**$43.32**
v02	10/02/23	2 bags 2P2S connectors for custom robot cables	**$31.40**
v03	10/03/23	Standard and high strength shafts for robot motion	**$81.13**
v04	10/03/23	V5 motor casing button head hex screws	**$26.91**
v05	10/09/23	Aluminum hex standoffs various sizes & thin locking nuts	**$219.52**
v06	10/09/23	6” Al standoffs, T15 8-32 screws, 6x3.25” antistatic omni wheels	**$220.18**
t01	10/12/23	RE-VRC-23-3391 Jan 7 Farmingdale Qualifier 2 Teams (cap)	**$175.10**
t02	10/21/23	RE-VRC-23-3401 Dec 9 Mount Academy Team A	**$87.55**
t03	10/21/23	RE-VRC-23-3401 Dec 9 Mount Academy Team B	**$87.55**
t04	10/21/23	RE-VRC-23-3401 Dec 9 Mount Academy Team C	**$87.55**
v07	10/29/23	Robot Pneumatics 10x Schraeder Valve	**$40.20**
v08	10/29/23	Robot pneumatics 15x double acting cylinders, 5x solenoid valve, fittings	**$645.90**
v09	10/29/23	4x VEX solenoid driver cables, HS clamping shaft collars	**$212.56**
v10	10/29/23	Robot pneumatics SMC tubing	**$47.94**
			$2,006.81

Budget Tracker

Budget - 2023 Costs (November 2023)

Receipt	Date	VEX Supplies, Tournament Registrations, Tournament Hosting	Total
t01	11/1/2023	RE-VRC-23-2437 Adelphi U 2/17/2024 registration A, B, C ($80/team)	**$247.20**
t02	11/1/2023	RE-VRC-23-2384 JFK 1/27/24 registration A, B ($90/team)	**$185.40**
t03	11/3/2023	RE-VRC-23-4745 Vaughn College 2/4/24 registration A, B, C ($85/team)	**$262.65**
v01	11/4/2023	6P (non HS) sprockets and chain	**$180.01**
v02	11/7/2023	2x Rotation Sensor	**$108.71**
v03	11/12/2023	Mini sprocket & chain kit	**$57.78**
v04	11/13/2023	3x Nylon sheet VRC legal 12x24x1/16"	**$83.95**
t04	11/20/2023	RE-VRC-23-1484 Wave WPI sign event Nov 30 2023 registration A	**$360.50**
t05	11/20/2023	RE-VRC-23-1484 Wave WPI sign event Nov 30 2023 registration B	**$360.00**
t06	11/20/2023	RE-VRC-23-1484 Wave WPI sign event Nov 30 2023 registration C	**$360.00**
v05	11/23/2023	6x SMC Air cylinder control solenoids	**$177.44**
e01	11/29/2023	1x new V5 smart field control for one field	**$222.23**
c01	11/28/2023	Binding Machine for Engineering Notebooks	**$35.59**
c02	11/28/2023	Binding Covers for Engineering Notebooks	**$16.15**
c03	11/28/2023	Plastic Combs binding supplies	**$7.49**
c04	11/22/2023	Laundry Baskets (containers for triballs)	**$17.98**
			$2,683.08

Budget Tracker

**Budget - 2023 Costs
(December 2023)**

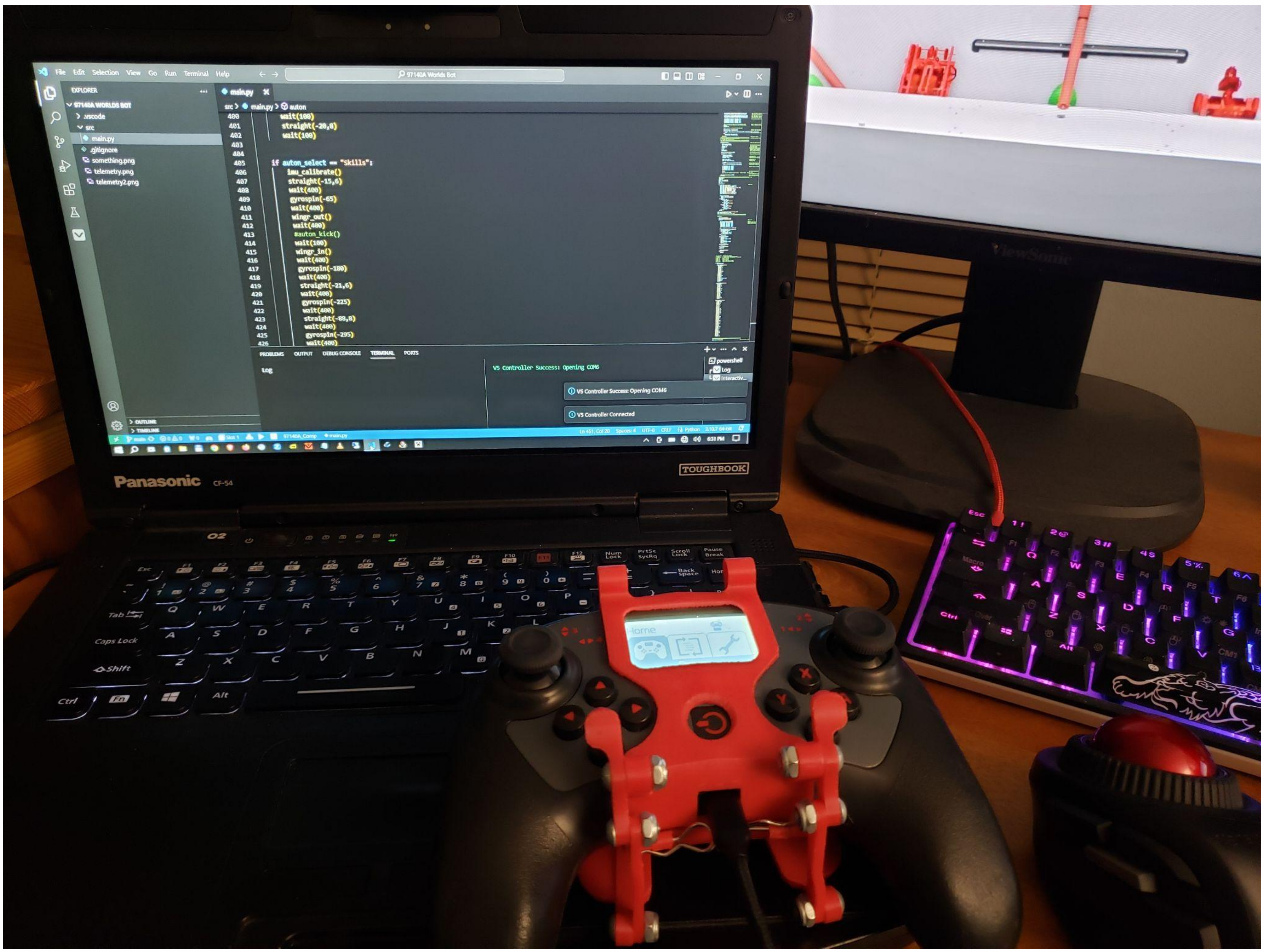
Receipt Code	Date	VEX Supplies, Tournament Registrations, Tournament Hosting	Total
v01	12/2/2023	8x 2.75" wheels and 1x2x35 Aluminum C-channel for Team A chassis rebuild	$271.78
v02	12/3/2023	6x 75mm air cylinders for robot pneumatics	$175.00
v03	12/3/2023	2x inertial sensors for Team B and C robots	$130.26
v04	12/4/2023	HS shaft bearing flats, adapters, pillow blocks	$252.22
v05	12/8/2023	HS gears (36T and 60T) for Team A chassis V2 rebuild	$140.55
v06	12/18/2023	HS shaft ball bearings and supports for all 3 teams	$108.63
v07	12/19/2023	Aluminum standoffs var sizes (1/2", 7/8", 1", 2", 4", 6")	$139.00
	12/19/2023	400 x thin nylock nuts for all 3 teams	$29.91
	12/5/2003	CustomInk Tshirts-Uniform for new members	$116.64
			$1,363.99

Total Spend Season to Date	($11,466.76)
Total Budget for All Three Teams	$13,000.00
Remaining	**$1,533.24**

CODE

This season we utilized:
- IDE: Microsoft Visual Studio Code (Windows & Linux)
- Programming Language: Python 3.11
- Versioning: Git
- Cloud sync: GitHub

python



Name: Mathew Achim
Date: 01/15/24
Project Name: Code
Witnessed by: A.Achim & J.Achim, Coaches/Mentors

```
# ---------------------------------------------------------------------------- #
#                                                                              #
#       Module:       main.py                                                  #
#       Author:       Kennedy Gaels 97140A                                     #
#       Created:      Sat Dec 16 2023                                          #
#       Description:  OverUnder Worlds Bot V2 - versioning by Git(Hub)          #
#                                                                              #
# ---------------------------------------------------------------------------- #

# Library imports
from vex import *

################################################################################    declare hardware devices

brain=Brain()
con=Controller()
lf=Motor(Ports.PORT3, GearSetting.RATIO_6_1, True)
lm=Motor(Ports.PORT2, GearSetting.RATIO_6_1, True)
lb=Motor(Ports.PORT1, GearSetting.RATIO_6_1, True)
rf=Motor(Ports.PORT7, GearSetting.RATIO_6_1, False)
rm=Motor(Ports.PORT9, GearSetting.RATIO_6_1, False)
rb=Motor(Ports.PORT10, GearSetting.RATIO_6_1, False)
arm=Motor(Ports.PORT8, GearSetting.RATIO_36_1, False)
kicker=Motor(Ports.PORT14, GearSetting.RATIO_36_1, True)
rot=Rotation(Ports.PORT6)
limiter=Limit(brain.three_wire_port.a)
sensor=Optical(Ports.PORT5)
imu=Inertial(Ports.PORT12)
climb=DigitalOut(brain.three_wire_port.b)
wingr=DigitalOut(brain.three_wire_port.e)
wingl=DigitalOut(brain.three_wire_port.f)


######################################################################################  driver control
# top 100 degs on rot
# 1deg arm = 7.22 degs motor

def drive_go(speed):                                                                 #just basic drive spin for
those silly timed moves
    lf.spin(FORWARD,speed,VOLT)
    lm.spin(FORWARD,speed,VOLT)
    lb.spin(FORWARD,speed,VOLT)
    rf.spin(FORWARD,speed,VOLT)
    rm.spin(FORWARD,speed,VOLT)
    rb.spin(FORWARD,speed,VOLT)

def drive_hold():                                                                    #in case a hard break is needed
(maybe defense)
    lf.stop(HOLD)
    lm.stop(HOLD)
    lb.stop(HOLD)
    rf.stop(HOLD)
    rm.stop(HOLD)
    rb.stop(HOLD)

def drive_coast():                                                                   #standard coast stop, prevents
overheating
    lf.stop(COAST)
    lm.stop(COAST)
    lb.stop(COAST)
    rf.stop(COAST)
    rm.stop(COAST)
    rb.stop(COAST)
```

```
def kick():
    kicker.spin(FORWARD, 12, VOLT)
    wait(300)
    while limiter.pressing() == 0:
        kicker.spin(FORWARD, 9, VOLT)
        wait(10)
    kicker.stop(COAST)

def sensor_kick():
    wait(300)
    kick()

def auton_kick():
    kicker.spin(FORWARD, 9, VOLT)
    wait(35000)
    kicker.stop(COAST)

def climb_assist():
    climb.set(True)

def imu_calibrate():
    brain.screen.draw_image_from_file("brainscreen.png", 0,0)                          #loads bitmap from SD card
    imu.calibrate()                                                                     #calibrates IMU
    brain.screen.set_pen_color(Color.YELLOW)
    brain.screen.print_at("CALIBRATING IMU...",x=250, y=50)
    brain.screen.print_at("PLEASE DON'T TOUCH",x=250, y=74)
    brain.screen.set_pen_color(Color.WHITE)
    wait(2000)

def wingl_out():
    wingl.set(True)

def wingl_in():
    wingl.set(False)

def wingr_out():
    wingr.set(True)

def wingr_in():
    wingr.set(False)

##############################################################################
#straight code                                                                      /-------------------\
#based on John TYler's motion profile C++ code                                     /                     \
#found in https://www.vexforum.com/t/57451                                        /    trapezoid          \
#https://www.robotmesh.com/studio/5c63790015d6a9044155d271                       /     profile             \
#                                                                               /                           \

def increasing_speed(starting_point, current_position) :                       #up slope function for start
trapezoid path
    minimum_velocity = 1.0                                                      #need to prevent stall around 0
    acceleration_constant = 125.0                                               #slope higher constant faster
acceleration
    return acceleration_constant * abs(current_position - starting_point) + minimum_velocity

def decreasing_speed(ending_point, current_position) :                         #down slope function for end
trapezoid path
    minimum_velocity = 1.0                                                      #need to prevent stall around 0
    deceleration_constant = 5.0                                                 #slope higher constant faster
deceleration
    return deceleration_constant * abs(ending_point - current_position) + minimum_velocity
```

```
def straight(distanceIn, maxVelocity) :
    iteration = 0
    minimum_velocity = 3.0                                                      #need to prevent stall around 0
    WheelSize = 2.75                                                            #diameter of drive wheel
    GearRatio = 0.75                                                            #gear ratio 48/36 4:3
    circumference = 3.14159 * WheelSize                                         #drive wheel circumference
    if distanceIn == 0: return                                                  #very basic input error check
    direction = 1 if distanceIn > 0 else -1                                     #direction flag for forward vs
reverse
    wheelRevs = distanceIn / circumference / GearRatio                          #convert distance in inches to
shaft encoder revs

    lf.spin(FORWARD, direction * minimum_velocity, VOLT)                        #set the motors to do a position
move with min velocity
    lm.spin(FORWARD, direction * minimum_velocity, VOLT)                        #this is just a way to make them
stop when arriving at target
    lb.spin(FORWARD, direction * minimum_velocity, VOLT)                        #and not stall at very low
power/velocity levels
    rf.spin(FORWARD, direction * minimum_velocity, VOLT)
    rm.spin(FORWARD, direction * minimum_velocity, VOLT)
    rb.spin(FORWARD, direction * minimum_velocity, VOLT)

    position_left  = lm.position(TURNS)                                         #record initial left side encoder
    position_right = rm.position(TURNS)                                         #record initial right side encoder

    leftStartPoint = position_left                                              #left side starting position
    leftEndPoint = leftStartPoint + wheelRevs                                   #left side ending position
    rightStartPoint = position_right                                            #right side starting position
    rightEndPoint = rightStartPoint + wheelRevs                                 #right side ending position

    while ((direction * (position_right - rightStartPoint) < direction * wheelRevs) or
           (direction * (position_left - leftStartPoint) < direction * wheelRevs)): #execute motion profile

        up_left_speed = increasing_speed(leftStartPoint,position_left)          #get left numbers from
increasing_speed function
        down_left_speed = decreasing_speed(leftEndPoint,position_left)          #get left numbers from
decreasing_speed function
        left_speed = min(maxVelocity, up_left_speed, down_left_speed)           #get minimum left speed following
trapezoid

        up_right_speed = increasing_speed(rightStartPoint,position_right)       #get right numbers from
increasing_speed function
        down_right_speed = decreasing_speed(rightEndPoint,position_right)       #get right numbers from
decreasing_speed function
        right_speed = min(maxVelocity, up_right_speed, down_right_speed)        #get minimum right speed following
trapezoid

        lf.spin(FORWARD, direction * left_speed, VOLT)                          #set calculated speed for all
motors
        lm.spin(FORWARD, direction * right_speed, VOLT)
        lb.spin(FORWARD, direction * left_speed, VOLT)
        rf.spin(FORWARD, direction * right_speed, VOLT)
        rm.spin(FORWARD, direction * left_speed, VOLT)
        rb.spin(FORWARD, direction * right_speed, VOLT)

        #brain.screen.draw_pixel(60*position_left,120-10*left_speed)            #used in testing to plot left
motion profile
        #brain.screen.draw_pixel(60*position_right,240-10*right_speed)          #used in testing to plot right
motion profile
        wait(10)
        iteration += 1
```

```
        #print (iteration, up_right_speed, down_right_speed)

        new_position_left  = lm.position(TURNS)                                     #read new left side encoder
position
        new_position_right = rm.position(TURNS)                                     #read new right side encoder
position

        if iteration > 50 and new_position_left == position_left and new_position_right == position_right:
            break                                                                   #if stall detected exits loop
        else:
            position_left = new_position_left
            position_right = new_position_right

    drive_hold()                                                                    #hard stop all motors

################################################################################    uses IMU to calculate spin point
# read https://georgegillard.com/resources/documents
# "An introduction to PID controllers"
# and  https://renegaderobotics.org/pid-beginners-guide/  before venturing here
################################################################################

def gyrospin(setPoint):                                                             #spins the robot using values from
the inertial sensor

    nowPoint = imu.rotation()
    error = setPoint - nowPoint                                                     #gets the starting error just in
case
    #ratio = error/20                                                               #not using it now, tried it to
scale power
    errorTotal = 0                                                                  #initialize variable
    errorLast = 0                                                                   #initialize variable
    kP = 0.5                                                                      #tunable proportioanal parameter
    kD = 0                                                                          #tunable derivative parameter
    kI = 0                                                                          #tunable integral parameter
    treshold = 0.2                                                                  #error treshold (precision)
    minturnspeed = 5                                                                #a minimum speed to avoid stall

    brain.screen.clear_screen(Color.BLUE)                                           #lets the entire world know we are
spinning

    while(abs(error) > treshold):                                                   #stop at threshold so we don't
calculate infinitely to the perfect angle

        nowPoint = imu.rotation()
        error = setPoint - nowPoint                                                 #calculate error
        errorTotal += error                                                         #accumulated error (for integral)
        errorLast = error                                                           #previous error (for derivative)

        pTerm = error * kP                                                          #proportional term
        iTerm = kI * errorTotal                                                     #integral term
        dTerm = kD * (error - errorLast)                                            #derivative term

        if error>0:
            power = max(minturnspeed,(pTerm + iTerm + dTerm))                       #the new power for motors when
under
        else:                                                                       #using a minimum speed instead of 0
to not stall
            power = min(-minturnspeed,(pTerm + iTerm + dTerm))                      #the new power for motors when over
```

```
        lf.spin(FORWARD, power, PERCENT)
        lm.spin(FORWARD, power, PERCENT)                                          #run all 6 motors with above power
        lb.spin(FORWARD, power, PERCENT)
        rf.spin(REVERSE, power, PERCENT)
        rm.spin(REVERSE, power, PERCENT)
        rb.spin(REVERSE, power, PERCENT)

        wait(10)                                                                  #so the brain does not get a
headache

        #print("imu %5.1f" %nowPoint,"er %5.1f" %error,"   P %5.1f" %pTerm,"   pw %5.2f" %power)
                                                                                  #a simple debug print to console

    brain.screen.clear_screen(Color.BLACK)                                        #returns background to black when
done
    drive_hold()                                                                  #puts a firm stop to all nonsense

######################################################################################   menu
imu_calibrate()
touch_x = 0
touch_y = 0
gray = Color(140,140,140)
gray2 = Color(100,100,100)
press = 0
run = True
auton_select = "-"

while run==True:                                                                  #print menu
#Main menu
    brain.screen.set_pen_width(1)
    brain.screen.set_fill_color(Color.TRANSPARENT)
    brain.screen.set_pen_color(Color.WHITE)
    brain.screen.draw_image_from_file("brainscreen3.png", 0,0)
    brain.screen.draw_rectangle(220,60,110,50)
    brain.screen.draw_rectangle(220,170, 110, 50)
    brain.screen.draw_rectangle(370,60, 80, 50)
    brain.screen.draw_rectangle(370,170, 80,50)
    brain.screen.print_at("Auto Far",x=225,y=90)
    brain.screen.print_at("Skills",x=375,y=90)
    brain.screen.print_at("Auto Near",x=225, y=200)
    brain.screen.print_at("Drive", x=375, y=200)


    if brain.screen.pressing():
        touch_x = brain.screen.x_position()
        touch_y = brain.screen.y_position()
        press = 1
    elif press == 1:
        if touch_x <= 350:
            if touch_y <= 120:
                auton_select = "Auto Far"
                run = False
            elif touch_y > 120:
                auton_select = "Auto Near"
                run = False
        elif touch_x > 350:
            if touch_y <= 120:
                auton_select = "Skills"
                run = False
            elif touch_y > 120:
                auton_select = "Drive"
                run = False
        press = 0
    wait(100)
```

```
brain.screen.draw_image_from_file("brainscreen.png", 0,0)
brain.screen.set_pen_color(Color.CYAN)
brain.screen.print_at(auton_select, x=350, y=220)

#################################################################################

def driver():

    con.buttonA.released(kick)
    sensor.object_detected(sensor_kick)
    con.buttonLeft.released(auton_kick)
    while True:                                                                #Drive loop

        axis_3=con.axis3.position()**3/80000                                   #0-12.5V
        axis_1=con.axis1.position()**3/80000                                   #0-6ish to make turns less
crazy
        rf.spin(FORWARD, axis_3-axis_1, VOLT)                                  #direct voltage drive disables
velocity PID
        rm.spin(FORWARD, axis_3-axis_1, VOLT)                                  #should reduce overheating
        rb.spin(FORWARD, axis_3-axis_1, VOLT)
        lf.spin(FORWARD, axis_3+axis_1, VOLT)
        lm.spin(FORWARD, axis_3+axis_1, VOLT)
        lb.spin(FORWARD, axis_3+axis_1, VOLT)

        brain.screen.print_at(rot.angle(), x=250, y=76)

        if con.buttonL1.pressing() and rot.angle()<184:
            arm.spin(FORWARD, 10, VOLT)
        elif con.buttonL2.pressing():
            if rot.angle() > 119:
                arm.spin(REVERSE, 10, VOLT)
            elif 118> rot.angle() > 94:
                arm.spin(REVERSE, 4, VOLT)
        else:
            arm.stop(BRAKE)

        if con.buttonX.pressing():
            kicker.stop(COAST)
            wait(100)
            kicker.spin(FORWARD, 5, VOLT)
            wait(10)
            kicker.stop(COAST)
            wait(100)
            kicker.spin(REVERSE, 5, VOLT)
            wait(10)
            kicker.stop(COAST)

        if con.buttonUp.pressing():
            climb_assist()

        if con.buttonR2.pressing():
            wingl_out()
        else:
            wingl_in()

        if con.buttonR1.pressing():
            wingr_out()
        else:
            wingr_in()
```

```
# imu_calibrate()   calibrates IMU (2 seconds)
# gyrospin(x)       x = absolute angle in degrees (0 at start)
# straight(x, y)    x = distance inches (minus backwards) y = volts (0-12)
# wingr_out()       extend right wing
# wingr_in()        retract right wing
# wingl_out()       extend right wing
# wingl_in()        retract right wing
# drive_hold()      stops all drive motors with HOLD
# drive_coast()     stops all drive motors with COAST

def auton():
    global auton_select

    if auton_select == "Auto Far":
        imu_calibrate()
        wingl_out()
        wait(100)
        straight(-5,8)
        wingl_in()
        wait(100)
        gyrospin(-10)
        wait(100)
        straight(-22,12)
        wait(100)
        straight(8,8)
        wait(100)
        gyrospin(20)
        wait(100)
        straight(27,8)
        wait(100)
        gyrospin(64)
        wait(100)
        arm.spin(FORWARD, 6, VOLT)
        wait(600)
        arm.stop(BRAKE)
        straight(26,5)
        wait(100)


    if auton_select == "Auto Near":
        imu_calibrate()
        wingr_out()
        wait(100)
        straight(-5,8)
        wait(100)
        wingr_in()
        wait(100)
        straight(-21,8)
        wait(100)
        straight(16,8)
        wait(100)
        gyrospin(60)
        wait(100)
        straight(-45,8)
        wait(100)
        wingr_out()
        wingl_out()
        wait(100)
        gyrospin(114)
        wait(100)
        straight(-20,8)
        wait(100)
```

```
    if auton_select == "Skills":
        imu_calibrate()
        straight(-15,6)
        wait(400)
        gyrospin(-65)
        wait(400)
        wingr_out()
        wait(400)
        #auton_kick()
        wait(100)
        wingr_in()
        wait(400)
        gyrospin(-180)
        wait(400)
        straight(-21,6)
        wait(400)
        gyrospin(-225)
        wait(400)
        straight(-88,8)
        wait(400)
        gyrospin(-295)
        wait(400)
        wingl_out()
        wait(400)
        straight(-40,8)
        wait(400)
        straight(8,6)
        wait(400)
        wingl_in()
        wait(400)
        gyrospin(-360)
        wait(400)
        straight(-36,6)
        wait(400)
        gyrospin(-255)
        wait(400)
        wingl_out()
        wingr_out()
        wait(400)
        straight(-30,8)
        wait(400)
        straight(10,8)
        wait(100)
        wingl_in()
        wingr_in()
        wait(100)
        straight(10,8)
        wait(100)
        gyrospin(-280)
        wait(400)
        wingl_out()
        wingr_out()
        wait(400)
        straight(-30,8)


######################################################################################

comp = Competition(driver,auton)                                                  #VEX comp class HAS TO EXIST
```

Innovate Award Submission Information Form

Only for events that are offering the Innovate Award: Either this form or an entry with the equivalent information is required to be eligible for the Innovate Award. Digital submissions can additionally use the Engineering Notebook link feature found in the "My Account" dashboard on RobotEvents.com.

Instructions: Please fill out all information, printing clearly. For in-person notebooks, please place this page either inside the front cover of the team's notebook or placed as the **last entry** in the notebook when submitting it for judging. In the case of digital notebooks, a picture of the form can be uploaded and placed either at the beginning of the digital notebook, after the Table of Contents, or entered as the last entry in the notebook. Teams may only submit one aspect of their design to be considered for this award at each event.

Full Team Number: 97140 A

Brief Description of the novel aspect of the team's design being submitted:

Modular robot with hot swappable subsystem 3 mechanisms. Kicker and Elevation Arm to be easily swapped out depending on alliance partner capability and also for Skills advantage.

Identify the page numbers and/or the section(s) where documentation of the development of this aspect can be found:

- 193, 194, 195, 196, 197, 198, 199, 200
-
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