36620B: Crusaders
Digital Engineering Notebook
2024-2025 High Stakes

36620B: Crusaders

Engineering (Digital) Notebook

Why notebook digitally

> Improves organization, neatness, and readability
> Utilizing modern methods of data presentation (graphs, tables, ect.) and logging

our approach (after every practice and competition)

> log a digital entry of **Important takeaways and progress in the Engineering design process**
> print the entries from the practices
> Put the entries in a 3 ring binder or notebook to keep a running physical copy of the notebook

Table of Contents

Note* page numbers might be 1-2 pages off due to spacing differences between printing.
Sorry for the inconvenience- The Crusaders

Team Member Overview

Name	Experience, skills, and role	Picture
Alec Tackitt	**Experience:** 5 years of Vex Vrc, 1 year of code red robotics, 1 year lego, 1 year of Aerial Drone Competition **Skills:** Experience in 7 programming languages Experience in multiple CAD suites (mainly Autodesk) **Roles:** Lead notebooker, CAD and sketch designeasar, Lead programer	
Cade Peters	**Experience:** 4 years of Vex Vrc , 2 years of Aerial Drone Competition, 2 Years coaching FLL Robotics **Skills:** Experience in Aviation, Drone piloting, Experience in coaching FLL **Roles:** Lead Driver, Assistant Notebooker, Build and Design Assist	
Jack Hoeve	**Experience:** 3 years of Vex Vrc, 1 year of Vex IQ **Skills:** Experience in Coding **Roles:** Assistant Builder, Spotter	

How to Read this notebook

Title	this text will be used for titles of projects
Subtitle	this font will be used for denoting subtitles of projects
LABEL	labels for diagrams, CAD designs, sketches, ect. Will Be all capitalized
$\boxed{\text{Heading}}$	A box around words indicates a heading
(page)	references a specific page that relates
Normal	most text will be written this way in standard typing
Important or **Important**	The most important text will be highlighted this way

First practice

Team goals

1. Learn to program something new

> this will allow us to be able to make more reliable programs that can increase points as well as advance our knowledge so programming is quicker and easier.

2. Utilize all scoring methods

> it is important when designing to look at all the parts of the game. This will allow us to better build a robot to work in alliances

3. Win a banner

> Banners are very exclusive and hard to obtain
> this will make us a more appealing alliance partner as it shows we can win harder competitions.
> and who doesn't like winning :)

4. Win 75% or more of qualification matches

> this will allow us to rank higher at competitions and have a higher chance to wil
> while this is ambitious it will help us to push the limits of being consistent and be the best we can.

5. Qualify for worlds

> there are multiple ways to qualify for worlds, but for our organization the best and potentially only way is through the 23 worlds seats at the MI state competition.
> The other advantage to qualifying through states is that the process of preparing for states and worlds is relatively the same.

Colors and tabs

(Physical notebook only)

Yellow	Identify Problem
Orange	Brainstorm solutions
Pink	Select and plan
Blue	Build Solution
Green	Test solution

Identify Problem Tab

Brainstorm solution Tab

Select and Plan Tab

Build Solution Tab

Test Solution Tab

Design process Iteration Tab

CAD Tab

Sketches Tab

Timeline Update Tab

DESIGN PROCESS

1. Identify the problem

>Problem description with words and pictures
>Problem statement
>Solution Requirements & Goals

2. Brainstorm Solutions

> Possible Solutions with positives and negatives
>Labeled Diagrams
>Citations from outside sources
>Prototyped Solutions

3. Select and Plan

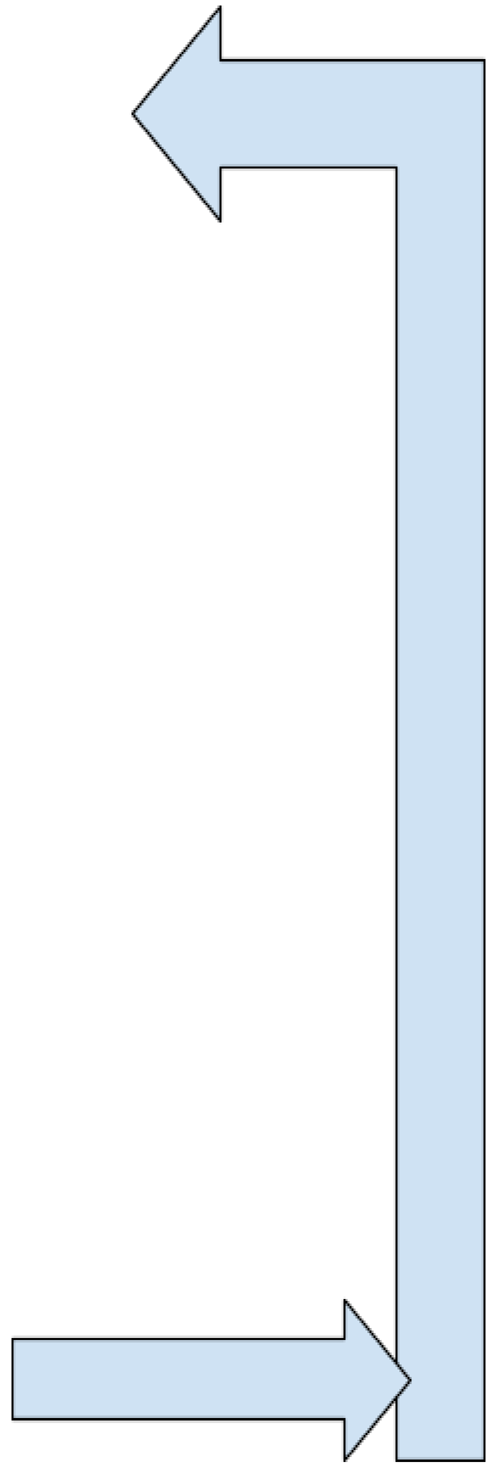
>Testing steps and results for prototypes
>Decision Matrix
>Sketches of Solution
>CAD Model of Solution

4. Build Solution

>Steps to build the Solutions
>Parts list for build
>Completed assembled build

5. Test solution

>Steps to test the solution
>Test Results
>Conclusion based on results

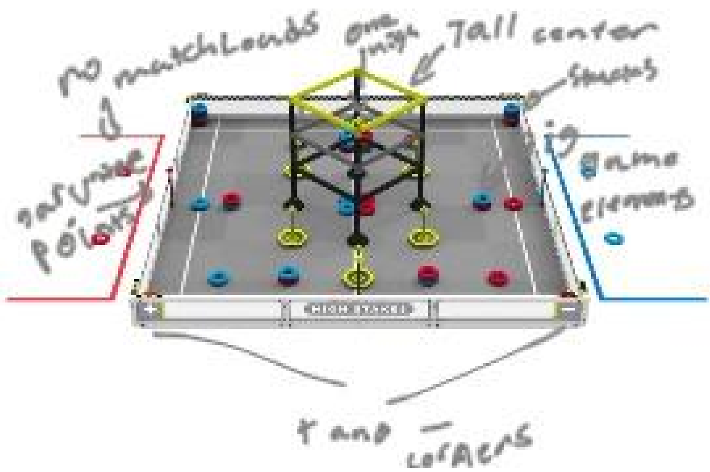


IDENTIFY GAME PROBLEM

<u>VRC High Stakes 2024-2025</u>

Goal	We will analyze VRC High Stakes so that we can better understand this year's game

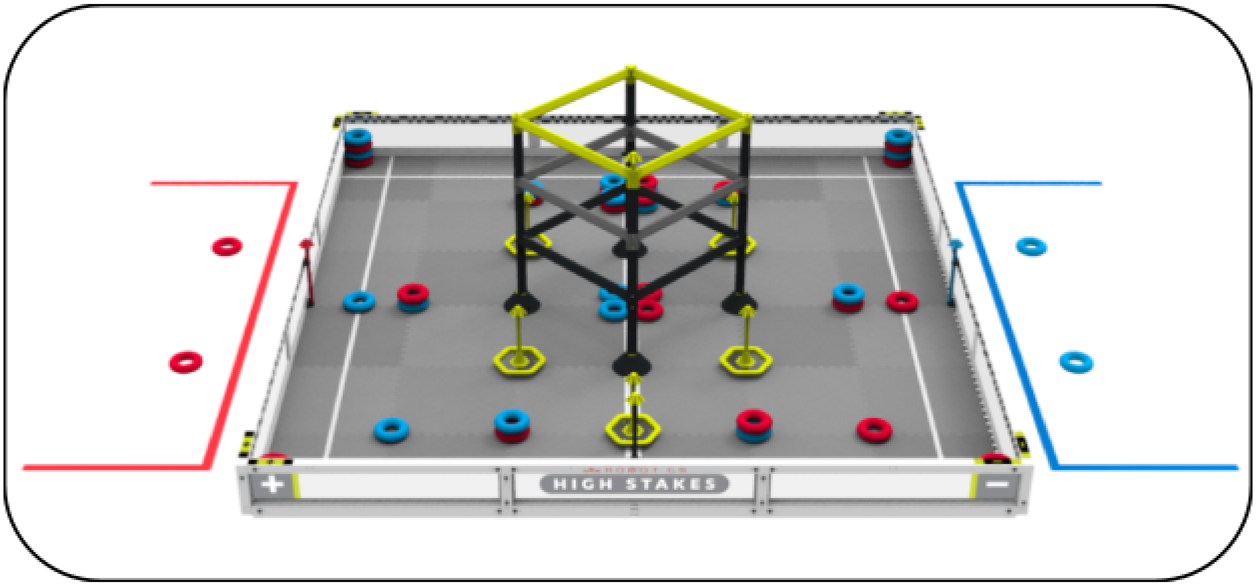
When the game first came out we took many initial observations



Here is the concise, typed out list

- Reused Games
- Can add and subtract opposing alliance's score
- Very tall center hanging
- Similar to tipping point - donuts on posts
- Only 4 places to put bases
- Single, high scoring post on top

Then we moved on to expanding definitions and objects of the field



Field Elements

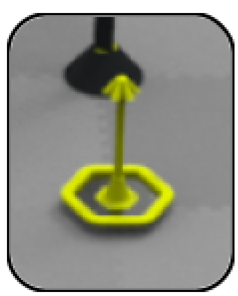
Ring

- Total of 48 rings in play
- 44 rings start on the field
- 2 preloads per alliance

1 pt on stake
3 pts top of stake
+/- depending on corner

Mobile Goal

- 5 goals - 1 Stake per goal
- 10” wide
- 14.5” tall
- 3.56” rubber top
-



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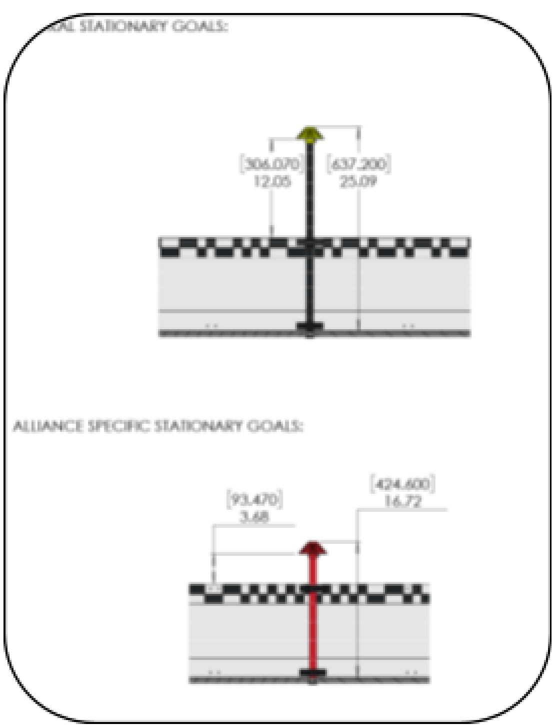
Ladder

- 3 different levels, higher is more points
- Has high stake on top for extra scoring

Corners

- 2 positive and 2 negative corners
- Rings on a mobile goal are either counted as positive or negative for each color alliance they are for
- Example: in the image, there is a negative corner, so each red ring is worth -1 points for the red alliance and the blue are also worth -1, but for the blue alliance



Wall Stake

- Stake like ones on goals
- Higher up on walls
- 2 normal and 2 alliance stakes

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Important Terms

Game Objects

> **Possession** - A Robot | game object status , a robot is in possession of a Game object if the robot is carrying, holding, or controlling the Movement of the Game object.
> **Scored** - A ring is scored if it is not contacting the floor or robots, is encircling a stake, and isn't over the stake limit

Match Play

> **Elevation tier** - a status of the robot, show how high the robot has elevated at the end of the match
> **Starting Tile** - tiles along the edge of the field perimeter Under each alliance station
> **Autonomous Period** - 15 second period at the beginning of each match without driver input.
> **Driver Controlled Period** - 1 minute 45 second time period following the autonomous period with driver input.

Violations

> **Holding** - A robot status if it meets any of these criteria

1. Trapping - Limiting the movement of an opposing robot to a small area without a way to escape

2. Pinning - Preventing the movement of an opposing robot through contact with the field perimeter or other robot

3. Lifting - controlling an opponents movement by raising or tilting the opponent's robot off the foam tiles

> **Match Affecting** -A Violation which changes the winning and losing Alliance in the Match.
> **Minor Violation** -A Violation which does not result in a Disqualification. Usually minor violations are accidental and/or momentary.
> **Major Violation** - A Violation which results in a Disqualification. Usually match affecting and intentional violations qualify as major.

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GAME RULES

VRC Over Under 2023-2024

Goal Understand the rules of this year's game to better brainstorm strategies

SG1

Standard rule that lays out the legal robot setup at the start of a match

1. Contacting at least 1 of the alliance starting tiles
2. Not contacting other robots
3. Not contacting any more than the 1 preload ring
4. Completely stationary

SG2

Limits horizontal expansion to 24"
Only expand in one direction in the x/y plane

SG3

Vertical expansion is limited to 2 ladder levels

SG4

Keep all scoring objects (rings and goals) in the field

SG6

Possession is limited to 2 rings

SG7

Don't cross auton line

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SG9

Don't remove opponents from the ladder

SG10

alliance wall stakes are protected

We also have developed a more in- depth list of rules/ rule changes besides the SG (standard game) rules:

- ***GAME***
- Added rules for "holding" than last year, including
    - Trapping - approx. 1 tile and has to be trying to escape
    - Pinning - same as last year
    - Lifting - new, exactly what it sounds like, no picking others up
- Clarity to major/minor violations and penalty
- Contacting barrier (middle bar and short extensions) is considered on the other side
- **Auton win point** is
    - 3 scored rings
    - 2 stakes with at least 1 ring
    - Neither robot breaking plane of starting line
    - One robot contacting ladder
- **30-second "endgame"** - corners are protected

- ***TOURNAMENT***
- extensive "field fault" issues resulting in match replays

- ***FIELD OVERVIEW***
- Specific ring stacks placement
- Rubber stake top is a little larger than ring hole

- ***SKILLS***
- Blue pre loads will not be used
- start in Red starting row

Game Strategies

VRC Over Under 2023-2024

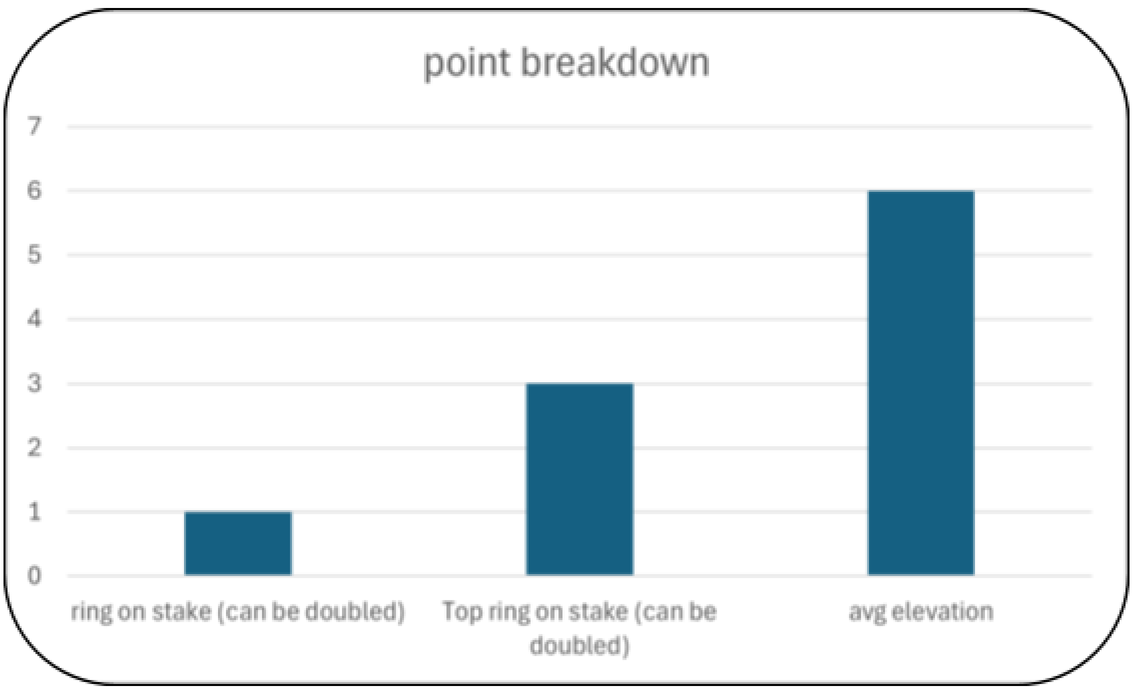
Goal

Develop strategies for this year's game so that we have a better idea on what to build and what to expect from other teams

Scoring methods and prioritization

Ways to score points

- 1 pt per ring on stake (can be doubled in corner)
- 3 pts for top rings on stake (can be doubled in corner)
- 3 pts base elevation tier (doubled per tier up, +2 pts for high stake bonus)



Observations

- High elevation is worth a lot, but takes a lot of effort
- Bonus for having the top ring on a stake
- Descoring is pretty hard
- The positive and negative corners may result in unique strategies to maximize point differential

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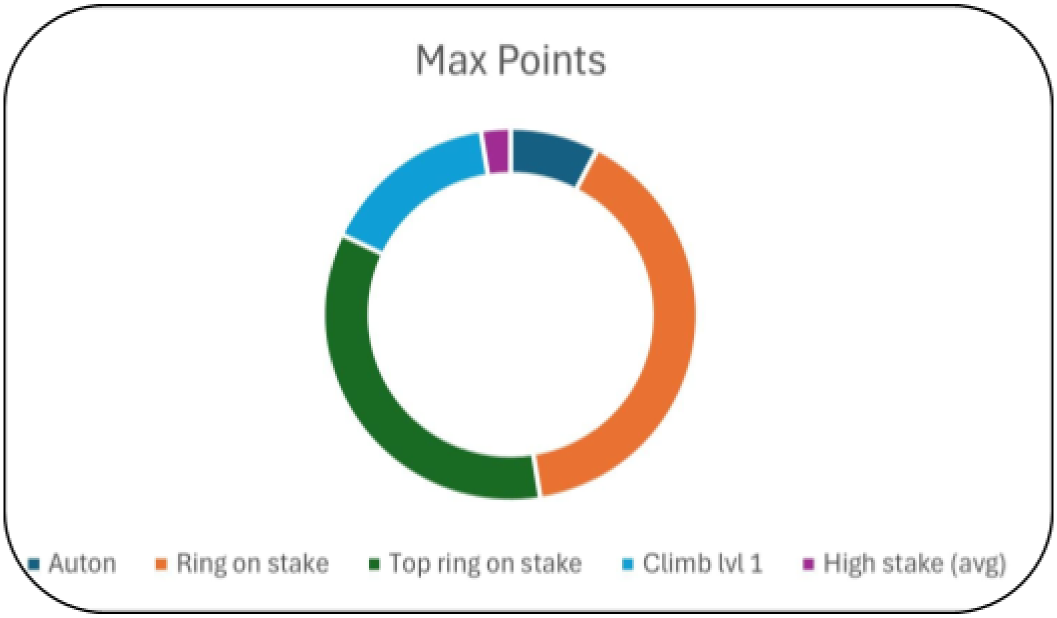
Total points

- 31 from rings on stakes
- Roughly 120 from triballs under goal (24 triballs)
- 116 pts from triballs in offensive zone (58)
- 8 pts from winning autonomous



Observations

- Big portion of points is having the top ring on a stake
- Can get a majority of points by fully filling a mobile stake with your rings
- Autonomous is not worth very much
- High stake is just a boost of points if the game is close

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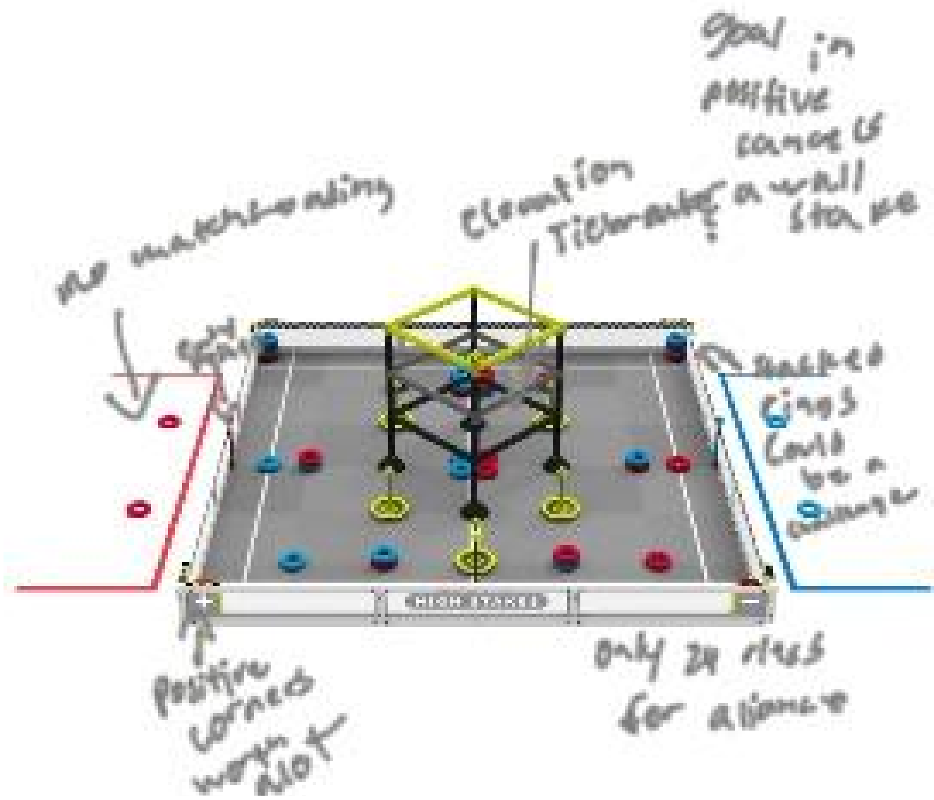
Initial strategies

After the initial game release we took down initial strategy ideas; then we took time to refine and find more ideas and turned them into pro-con statements for offensive and defensive strategies.



- The speed of filling goals with your rings is very important
- Similar to tipping point in strategy with added complexity in the pos/neg corners
- The game will be very speed dependent, and will have to wait and see what corners are worth playing for

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Offensive Strategies

Putting rings on mobile stakes

Positives	Negatives
• Scores the ring • Fastest way to gain points	• Limited space • Worth the least

Putting Rings on wall stakes

Positives	Negatives
• Additional points • Have an alliance/protected one	• Harder to reach • Not as many places to score

Elevate as high as possible

Positives	Negatives
• Extra points in case the game is close • Can be done by both robots	• Hard to engineer a robot that can hold itself up • Can't go back down after you go up

Put mobile stakes in the positive corner

Positives	Negatives
• Double points of all of our rings on the stake • Easy to do	• Can leave stake exposed to be stolen • Can score points for opponents if they have rings on the stake

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Defensive Strategies

Put opponents goals in negative corner

Positives	Negatives
• Cancels out all the rings on that goal • Distracts opponents from getting more rings	• Not adding to our score • Can easily be reversed

Descoring opponents rings

Positives	Negatives
• Subtracts from opponents score • Creates places to score our own rings	• Pretty hard to do and takes a while • Easy for opponents to counter by putting more on afterwards

Pushing other robots around

Positives	Negatives
• Prevents opponents from scoring efficiently • Good strategy to do if our goals are full	• Takes away from scoring ourselves • Can lead to vi

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Roadmap

Vex Over Under 2023-2024

Goal

Develop a roadmap and Gnatt chart to plan out our season and manage our time efficiently

The plan for this season is to take observations at the game release, then follow the engineering design process, starting with Identifying the problem , designing in drawing and CAD after the rulebook gets released. Then start some of the building early to mid-summer and get most of the building done by September (will have to take breaks because of summer camps and other obligations). The programming will happen somewhat in tandem with building, though after the first robot, we may attempt to incorporate more advanced autonomous programming and code such as a telemetry screen and an auton control system such as pure pursuit. Our first competitions will likely be throughout the fall (mega league), and the finals in October, so we have set a deadline for Ourselves to be done with the first implementation of the robot by mid-late October. After that we will Start the engineering design process on the second robot.Also, we will also be adding some extras that we are doing in the robotics club overall, such as designing the shirts, any storage room equipment Alec makes, etc. we won’t have a dedicated section to them so we can keep the timeline in the notebook straight but will be adding hyperlinks (Digital) or tabs (physical) in the table of contents in case anyone wants to check them out.

We plan to check in with this roadmap and goals every month or so to make sure we’re staying on track.

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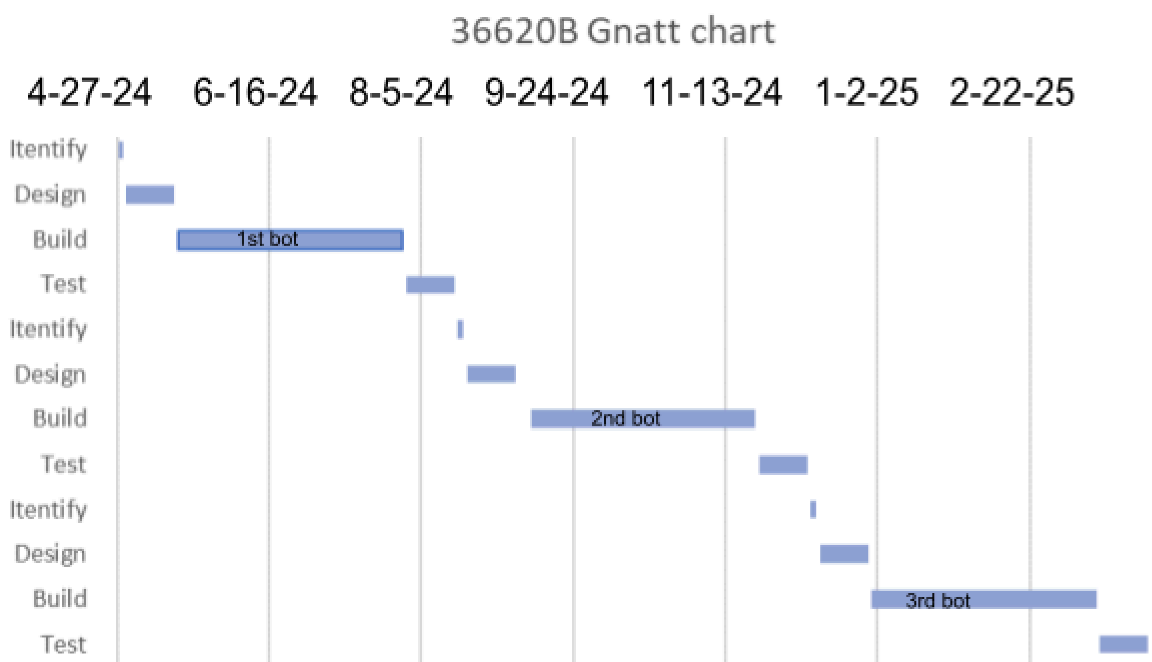
<u>Gnatt chart</u>



This Gnatt chart serves as a guideline for where we should be throughout the year, It will help us manage our time more effectively.

*note: the schedule has a little bit of flexibility that is not shown in the Gnatt chart. This is so we can keep hard deadlines for ourselves and not procrastinate. Though in the end if a section is not 100% on time it is not the biggest deal.

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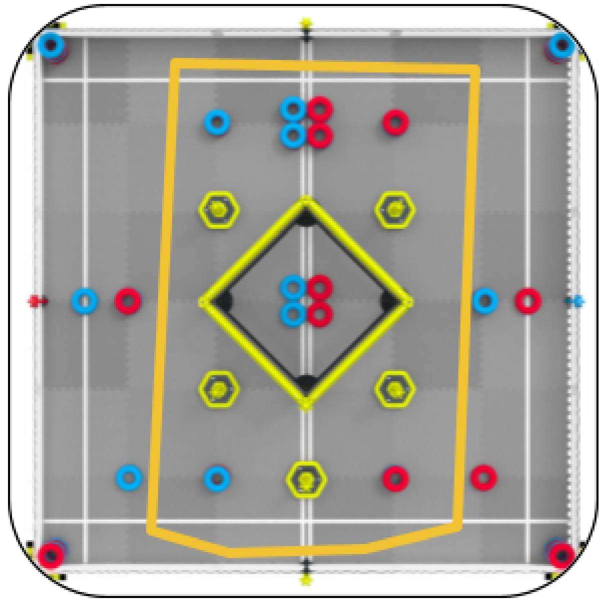
Identify Problem

Drivetrain

Goal

We will identify the needs of our robot's drivetrain so that we can brainstorm a solution and build an effective drivetrain.



Problem Statement

We need an effective mechanism to move across the field so that we can pick up game objects.

Solution Requirements

- Must use legal Vex Robotics Competition parts
- Must fit within the 18”x18”x18” starting cube
- Must use no more than 66 watts of motor power

Solution Goals

- Make a lap of the field in less than 8 seconds
- Turn 360 Degrees in less than 1 second
- Be able to push a 15Lb robot

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Brainstorm solutions

Drivetrain

Goal

Brainstorm possible solutions for a drivetrain so we can select the best one to use on the robot design.

Possible Solutions - drivetrain options

Things to consider
- Amount of wheels, more can increase acceleration and improve certain types of drivetrain
- Amount of motors, can affect how many wheels we may want to use
- If the drivetrain will be geared, can affect spacing of the wheels
- Size of wheels, how low should the robot be

Standard Omnidirectional wheels
- Omnidirectional wheels set up in a standard square configuration
- Most common type of drivetrain
-

Positives	Negatives
● Fast ● Simple ● Zero point turning	● Low traction, easy to get pushed ● Moves only on 2 axis

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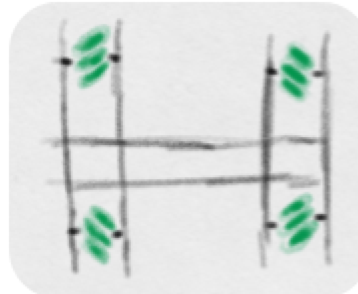
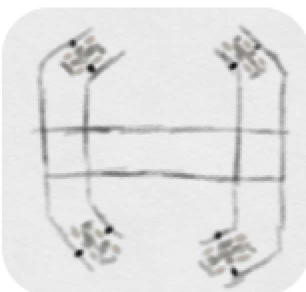
Mecanum wheels (Top view)

- Special omnidirectional (omni) wheels that have the rollers rotated 45 degrees
- Set up in tank drive orientation
- Second most popular drivetrain type



Positives	Negatives
• Nimble • Can move in all directions • In standard tank configuration	• Low traction • Harder to driver control/ is different • Lower torque delivery than others



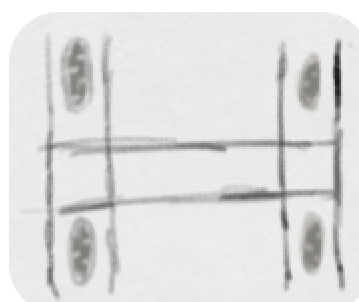
Holonomic / X-Drive (Top view)

- Omnidirectional wheels set up in a hexagonal shape
- 2 sets of parallel lines with each wheel oriented 45 degrees of of standard tank drive
- Pretty common drivetrain type

Positives	Negatives
• Very fast • Moves in all directions • Fast turning	• Complex and hard programing • Almost no torque • Larger drivebase

Traction Wheels (Top view)

- Wheels designed for best traction
- Set up in tank orientation



Positives	Negatives
• Best traction • Simple • compact	• Hard to turn sharp, no 0-point • increased traction

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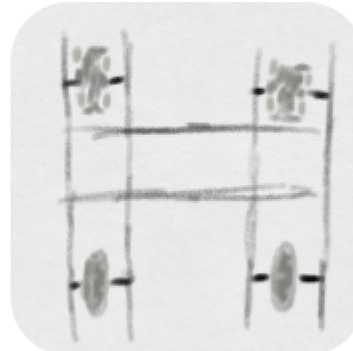


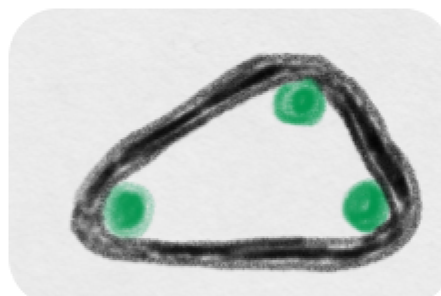
Omni and traction wheels (Top view)

- Omni and traction wheels set up in a tank drive orientation
- Omnidirectional wheels and traction wheels on same side

Positives	Negatives
• Good traction • Good speed • Simple	• Not the greatest turning • Slow due to more traction • Not the best at anything

Tank tread (Side view)

- Sprockets connected by tread in the VEX tank tread kit
- Sprockets are oriented in a triangle that is parallel to the ground



Positives	Negatives
• Great traction • Strong • Best at climbing over objects	• Slow • Slow turning

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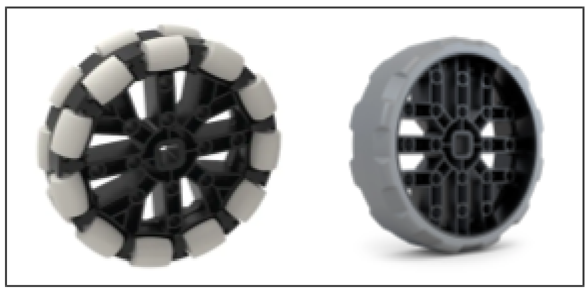
Possible Solutions - Wheels size

4” omni/traction wheels
- Each wheel in a drivetrain would be 4”
  - Most common wheel size

Positives	Negatives
• Very fast • Common wheel size	• Can’t climb things very well • Poor center of gravity (too high)

3.25” omni/traction wheels
- Each wheel in a given drivetrain would be 3.25”



Positives	Negatives
• Thin and small • Good speed and strength • Low center of gravity	• Less traction • Smaller - harder to work with

Possible solutions - Cartridge Type

Red Cartridge

- Spins up to 100 RPM
- Used for mechanisms that require extra torque

Positives	Negatives
• Excellent torque • Good acceleration	• Very slow • Loses lots of speed to friction

Green Cartridge

- Spins to 200 RPM
- Used for mechanisms that require decent speed but need some extra torque

Positives	Negatives
• Good balance between torque and speed • Don't have to change the cartridge	• Loses speed to to friction in cartridge • Doesn't excel in any statistic

Blue Cartridge

- Spins to 600 RPM
- Used in mechanisms that need speed but not a lot of torque

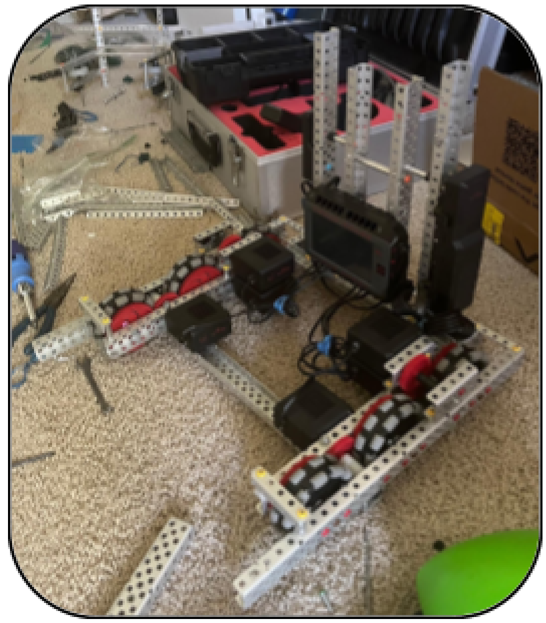
Positives	Negatives
• Very Fast • Little friction on the motors	• Least amount of torque Alec Tackitt 7/1/2024

Prototyped Solutions

We have decided to prototype the three most likely solutions we will use to gather data and decide which drivetrain setup will best suit the completed robot.

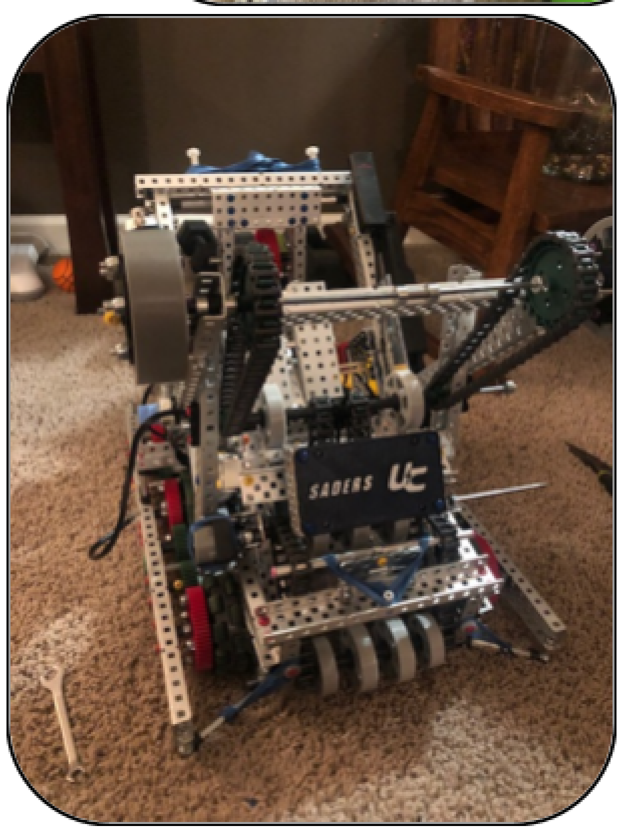
Omni wheel drive

- 6, 3.25” omni wheels that are attached via a 60:36 gear reduction (360 rpm) to motors with blue cartridges. This was done for a good balance of speed and torque



Omni/Traction wheel

- Same setup as two years ago
- 6 wheels, 4 3.25” omni with 2 3.25” tractions in between
- To save time we gathered data from spin up robot since it was still fully built



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Mecanum wheels

- 4 mecanum wheels positioned normally
- Allows movement in all directions
- Again we reused a old bot to speed the process up, though on this one we removed everything we could to ensure as fair of a test as possible

Select and Plan

Drivetrain

Goal

Select the best possible solution for the robot through data and a decision matrix

***note:** some data was used from previous years. We decided to do this as no testing variables were changed, eg. green vs blue motors, re-using data also saves us a bunch of time, compared to retesting the same setups. We are confident this data is accurate and will represent good data points for us to make our decisions

Prototype Testing

Test 1: Rotation

Test processes

- Place robot on foam tiles
- Upload a program that executes 100 rotations
- Run program and start a stopwatch
- Stop the stopwatch when the prototype stops
- Record results

Table is in seconds

Trial	1	2	3	4	5
Omni	82.041	83.004	82.763	84.223	83.033
Omni/traction	115.036	113.042	114.021	114.238	115.021
mecanum	135.024	138.921	140.812	138.231	136.012

	Omni	Omni/traction	Mechanum
Average	83.013	114.272	137.8
Range	2.182	1.994	5.788

Fastest: 6 motor omni

Most precise: omni/traction

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Test 2: speed

Test process

- Place prototype so that the back touches the wall
- Drive prototype around the field in a 3 lap “race”
- Start the stopwatch when the bot starts and end it when it has driven the 3 laps
- Record results

Table is in seconds (average lap time per race)

Trial	1	2	3	4	5
Omni	11.821	11.543	11.368	11.921	12.712
Omni/traction	13.621	13.754	13.393	14.174	13.855
mecanum	10.831	11.254	9.924	11.032	10.941

	Omni	Omni/traction	Mechanum
Average	11.873	13.759	10.796
Range	1.344	.788	1.33

Fastest: Mecanum

Most consistent: omni/traction

Test 3: Push

Test process

- Place prototype so that the back touches the wall
- Place Tower takeover robot (15.7 Lbs) 6” in front of prototype
- Move prototype forward with joystick and start stopwatch
- Stop stopwatch when Tower takeover robot hits the opposite wall
- Record results

Table is in seconds

Trial	1	2	3	4	5
Omni	4.821	4.612	5.024	5.002	4.924
Omni/traction	4.145	4.351	3.995	4.182	4.241
mecanum	5.512	5.815	5.251	6.162	5.941

	Omni	Omni/traction	Mechanum
Average	4.877	4.183	5.736
Range	.412	.356	.911

Fastest: 6 motor omni/Traction
Most precise: omni/traction

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Decision Matrix - Drivetrain type

Speed	How easy the chassis moves
Maneuverability	How easily the chassis can move around the field
Rotation	how quickly and easily the chassis turns
Strength	How strong the chassis is

	Speed	Maneuverability	Rotation	Strength	Total
Omni	4	4	5	4	17
Omni/Traction	3.5	3.5	4	5	16
Mecanum	4.5	4.5	3	2.5	14.4

Decision - Due to the outstanding composite score of a 6 wheel omni drivetrain on the design, given this we need to find the right wheel size for the chassis.

Decision Matrix - Wheel Size

Speed	How easily the wheel spins
COG	how low the wheels place the center of gravity
Acceleration	how quickly the wheels accelerate
Strength	how strong the wheel is

	Speed	COG	Acceleration	Strength	Total
4” wheel	5	3	3	3.5	14.5
3.25” Omni/Traction	4	4	4.5	5	17.5
2.75” omni	3	4.5	5	4.5	17

Decision - we will utilize the 3.25” wheels with a 6 motor drivetrain because of its high composite score on the decision Matrices. Given both these decisions we will now decide what cartridge to put in the motors

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Decision Matrix - Motor cartridge

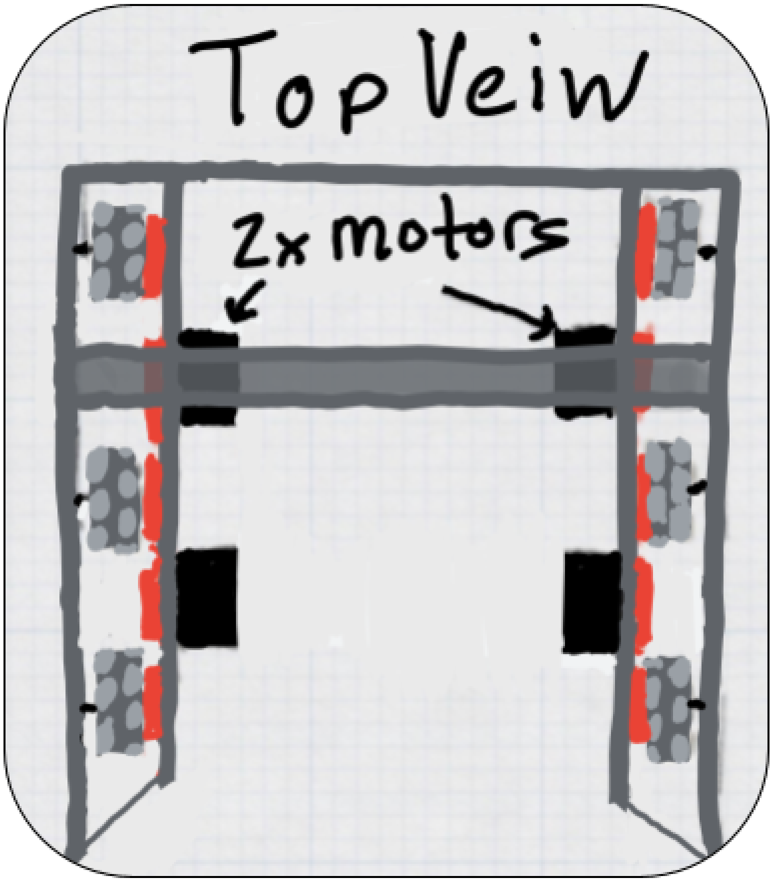
Speed	How easily the wheel spins
Friction	How much friction is placed on the motor
Acceleration	how quickly the wheel accelerates
Strength	How strong the cartridge is

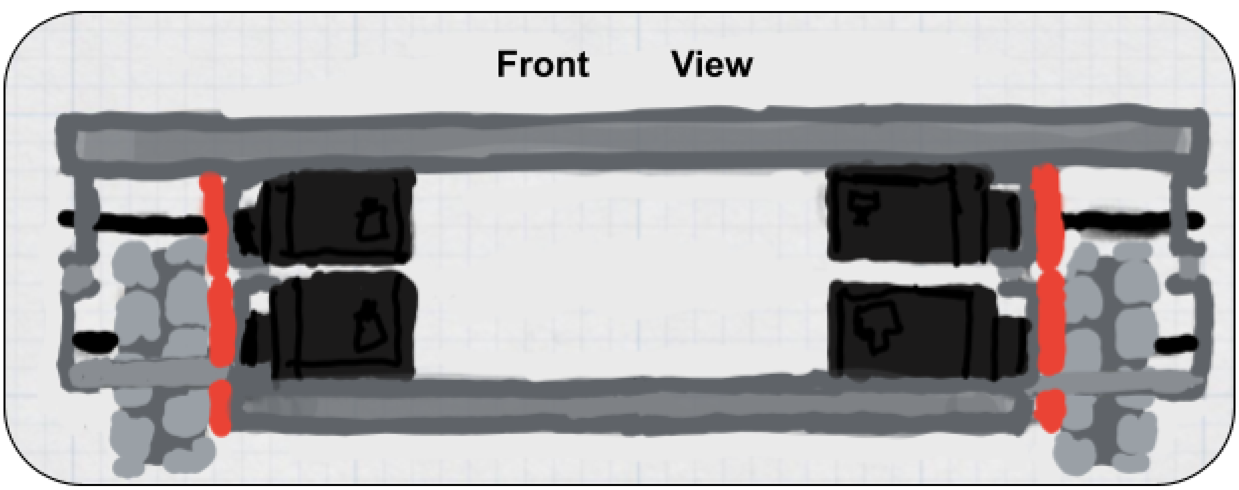
	Speed	Friction	Acceleration	Strength	Total
Red cartridge	1	3	5	5	14
Green cartridge	3	4	4	4	15
Blue cartridge	5	5	4.5	3	17.5

We will use a blue cartridge in the motors on a 3.25” omnidirectional 6 motor drive, geared down 64:30t (360 RPM) as it takes the advantages of speed, friction, and acceleration highlighted above and adds more strength to that, making it the ideal chassis design.

Alec Tackitt 7/5/2024

Sketch Plan



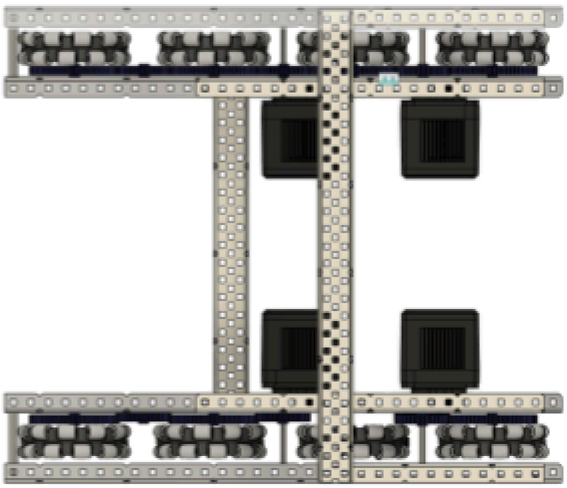


These sketches are a rough draft for what we expect the chassis to look like. We will use aluminum to reduce the weight of the chassis, doing this will increase the acceleration and speed of the robot. We will also stack the back motors to save space closer to the ground.

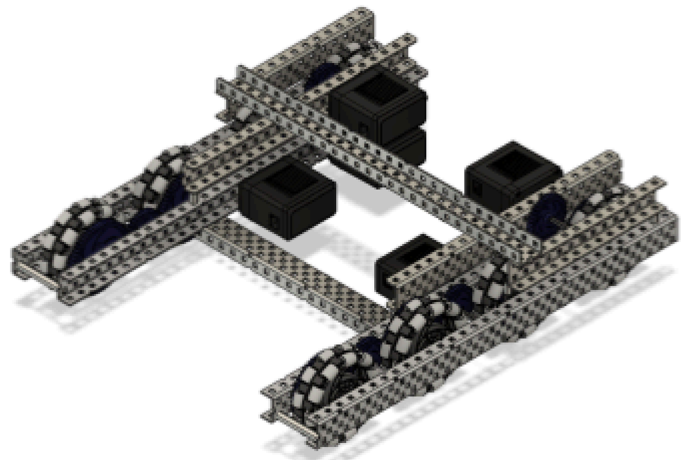
Cade Peters 7/8/2024

Cad Plan

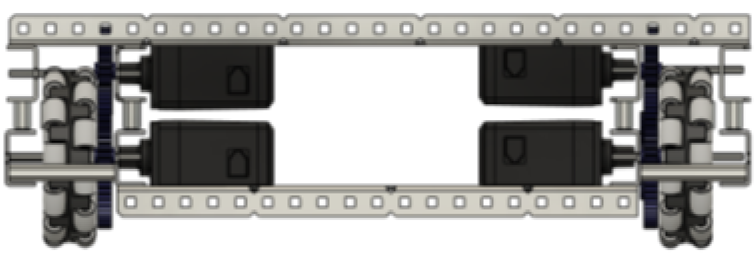
(Top View)



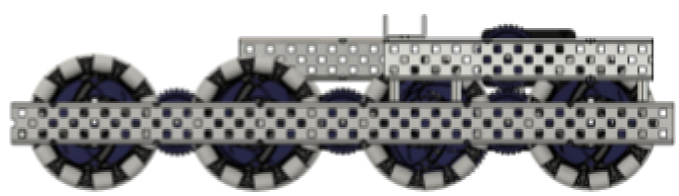
(Isometric View)



(Front View)

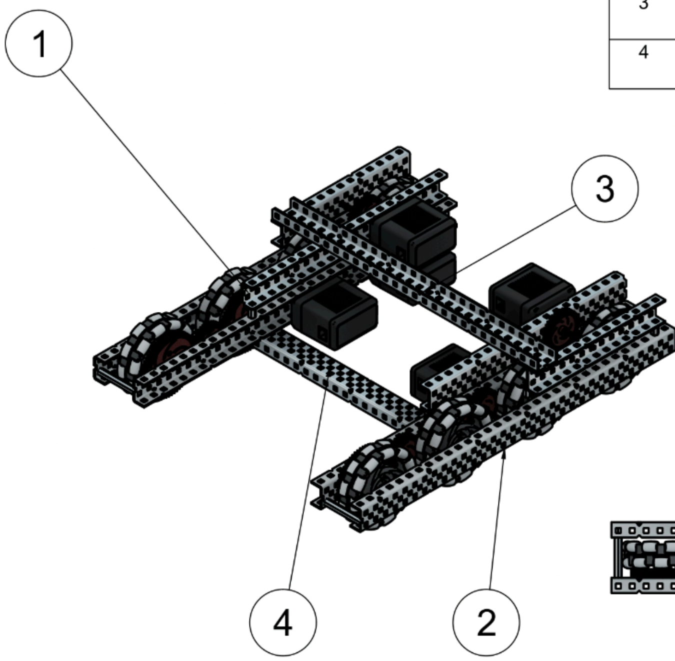


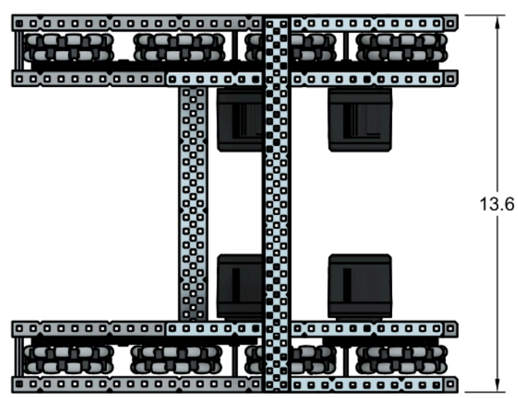
(Side View)

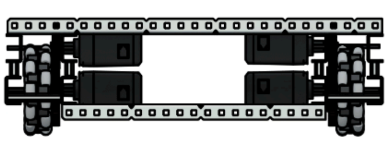


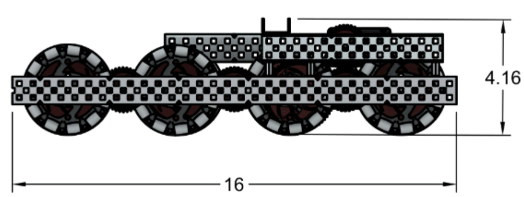
Alec Tackitt 7/2/2023

PARTS LIST			
ITEM	QTY	PART NUMBER	MATERIAL
1	1	RIGHT DRIVE SIDE	
2	1	LEFT DRIVE SIDE	
3	1	27 HOLE C CHAN BRACE	ALUMINUM 5052 H32
4	1	19 HOLE C CHAN BRACE	ALUMINUM 5052 H32









	PROJECT 36620B Robots			
	TITLE Robot 1 24-25			
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN alec tackitt 9/7/2024	SCALE 1:4	WEIGHT	SHEET 1/2	

PARTS LIST			
ITEM	QTY	PART NUMBER	MATERIAL
2.2.1	1	3.25 OMNI WHEEL V1	
2.2.1.1	2	SQUARE INSERT	STAINLESS STEEL, ANODIZED - BLACK
2.2.1.2	2	ROUND INSERT	ACETAL RESIN, DARK SEA GREEN
2.2.1.3	1	3.25 INCH ONMI WHEEL	
2.2.2	4	LS 60T GEAR V1	ACETAL RESIN, DARK SEA GREEN
2.2.3	3	3.25 INCH ONMI WHEEL	
2.2.4	2	C-CHAN ALU (16")	ALUMINUM 5052 H32
2.2.5	4	LS 36T GEAR V1	ABS PLASTIC
2.2.6	3	276-4840	
2.2.6.1	1	GEAR CARTRIDGE AND SHAFT	
2.2.6.2	1	MOTOR	V5 MOTOR
2.2.7	1	C-CHAN ALU (10")	ALUMINUM 5052 H32
2.2.8	6	STANDOFF (.5")	ALUMINUM 5052 H32
2.2.9	1	STANDOFF (2")	ALUMINUM 5052 H32
2.2.10	1	2X C-CHAN ALU V1 (2)	ALUMINUM 5052 H32
2.3	1	27 HOLE C CHAN BRACE	ALUMINUM 5052 H32
2.4	1	19 HOLE C CHAN BRACE	ALUMINUM 5052 H32

PARTS LIST			
ITEM	QTY	PART NUMBER	MATERIAL
2	1	DRIVETRAIN	
2.1	1	RIGHT DRIVE SIDE	
2.1.1	4	LS 36T GEAR V1	ABS PLASTIC
2.1.2	1	3.25 OMNI WHEEL V1	
2.1.2.1	2	SQUARE INSERT	STAINLESS STEEL, ANODIZED - BLACK
2.1.2.2	2	ROUND INSERT	ACETAL RESIN, DARK SEA GREEN
2.1.2.3	1	3.25 INCH ONMI WHEEL	
2.1.3	4	LS 60T GEAR V1	ACETAL RESIN, DARK SEA GREEN
2.1.4	3	3.25 INCH ONMI WHEEL	
2.1.5	2	C-CHAN ALU (16")	ALUMINUM 5052 H32
2.1.6	3	276-4840	
2.1.6.1	1	GEAR CARTRIDGE AND SHAFT	
2.1.6.2	1	MOTOR	V5 MOTOR
2.1.7	4	STANDOFF (.5")	ALUMINUM 5052 H32
2.1.8	1	C-CHAN ALU (10")	ALUMINUM 5052 H32
2.1.9	1	GEAR CARTRIDGE AND SHAFT	
2.1.10	1	STANDOFF (2")	ALUMINUM 5052 H32
2.1.11	1	2X C-CHAN ALU V1 (2)	ALUMINUM 5052 H32
2.2	1	LEFT DRIVE SIDE	

PROJECT: 36620B Robots				
TITLE: Robot 1 24-25				
APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	B			
DRAWN alec tackitt 7/20/2024	SCALE 1:4	WEIGHT	SHEET 2/2	

Build Solution

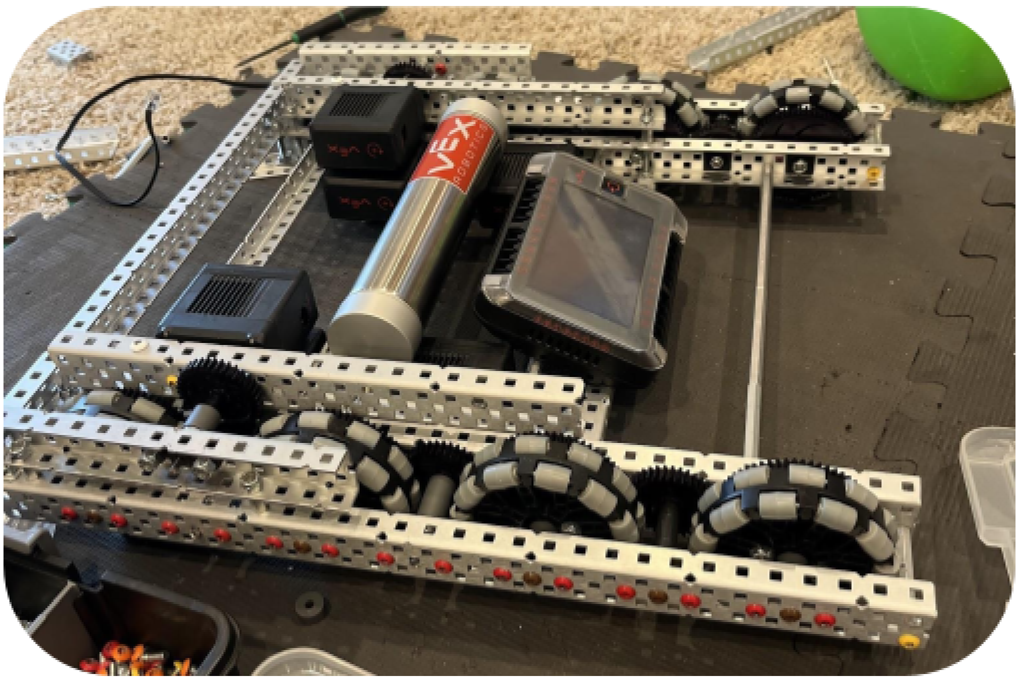
Drivetrain

Goal

Build the planned solution so that we can test it’s performance

Assembled Build

(Isometric View)



On the previous page and this page is the completed 6 motor omni wheel drivetrain, we attached a few crossbeams to attach the brain and pneumatic tank onto for more accurate testing as there are both things we will need on our robot, making a more precise minimum weight, this will affect the results positively as it will give more accurate results. The build was fairly simple due to the advanced planning and CADing. The build is unique due to the gearing of the motors to increase torque and stacking the back two to allow more room in the front of the bot.

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Test solution

<u>Drivetrain</u>

Goal	Test the solution so that we can see if it meets our requirements and goals

Test 1: Rotation

Test processes

- Place the robot on foam tiles
- Upload a program that executes 100 rotations
- Run the program and start a stopwatch
- Stop the stopwatch when the prototype stops
- Record results

Table is in seconds

Trial	1	2	3	4	5
6 motor Omni	42.516	41.124	41.731	41.621	42.326

Average 41.864 Range 1.392

Test 2: Speed

Test process

- Place prototype so that the back touches the wall
- Drive prototype around the field in a 3 lap “race”
- Start the stopwatch when the bot starts and end it when it has driven the 3 laps
- Record results

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Table is in seconds (full 3 lap race)

Trial	1	2	3	4	5
Omni	23.621	23.754	23.393	24.174	23.855

Average 23.579 Range .781

Test 3: Push

Test process

- Place the prototype so that the back touches the wall
- Place old robot (15.7 Lbs) 6” in front of the prototype
- Move the prototype forward with the joystick and start a stopwatch
- Stop stopwatch when Tower takeover robot hits the opposite wall
- Record results

Table is in seconds

Trial	1	2	3	4	5
Omni	5.174	4.621	5.024	5.172	4.924

Average 4.983 Range .553

Conclusion

- Make a lap of the field in less than 8 seconds Success
- Turn 360 Degrees in less than 1 second Success
- Be able to push a 15Lb robot Success

The built drivetrain successfully achieved 3/3 of our goals, we are excited to expand and build on top of the chassis

Alec Tackitt 7/30/2024

Identify Problem

Game object manipulation

Goal

Identify the objective of manipulating game objects so that we can brainstorm a solution to the objective

Problem Statement

We need a mechanism to transport the goals around the field

Solution Requirements

- Must use legal Vex Robotics Competition parts
- Must fit within the 18”x18”x18” starting cube
- Must use no more than 22 Watts of motor power

Solution Goals

- Be able to successfully grab the goal 100% of the time
- Be able to position the goal in the correct spot to put rings on
- Be able to last the entire match

Alec Tackitt 8/2/2024

Brainstorm solutions

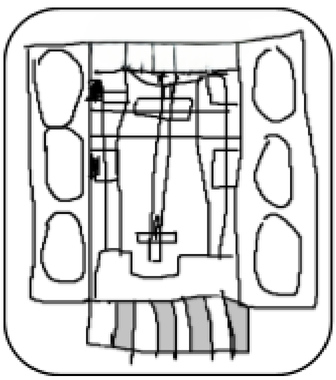
Game object Manipulation

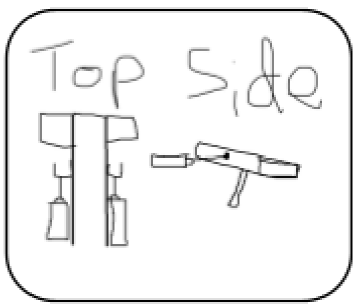
Goal	Brainstorm possible solutions to manipulating game objects so that we can select the best ones to prototype for the team.

Possible solutions - game object manipulation

Clamp

- Design similar to 2021-2022 season tipping point robot goal clamps
- One moving hook that pinches goal against a flat surface

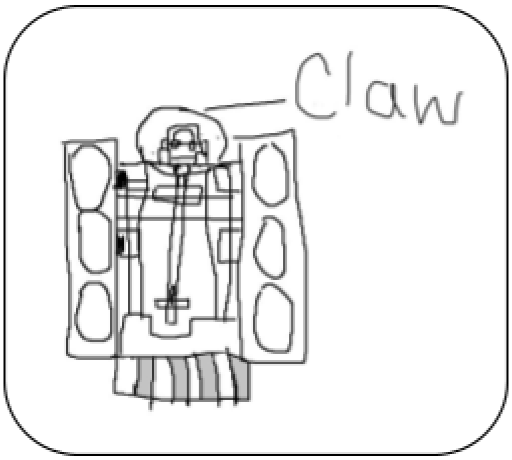




Positives	Negatives
• Easier to build • simple • Can be pneumatic powered	• Not the strongest grip • Can't lift as much weight

claw

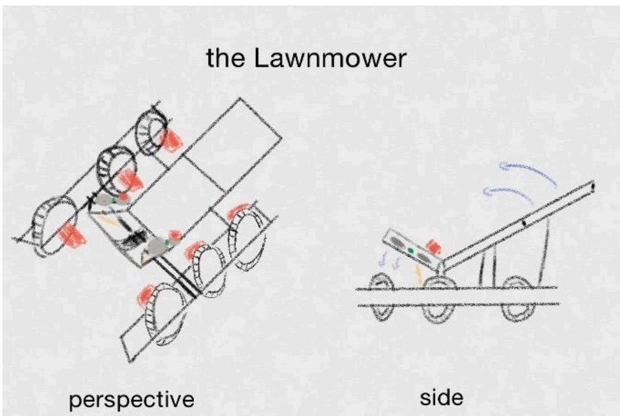
- Similar to clamp but clamps from either side



Positives	Negatives
• Strong grip • Compact • Can lift a lot of weight	• Has to be motor powered • More complex • Slower speeds

Lift

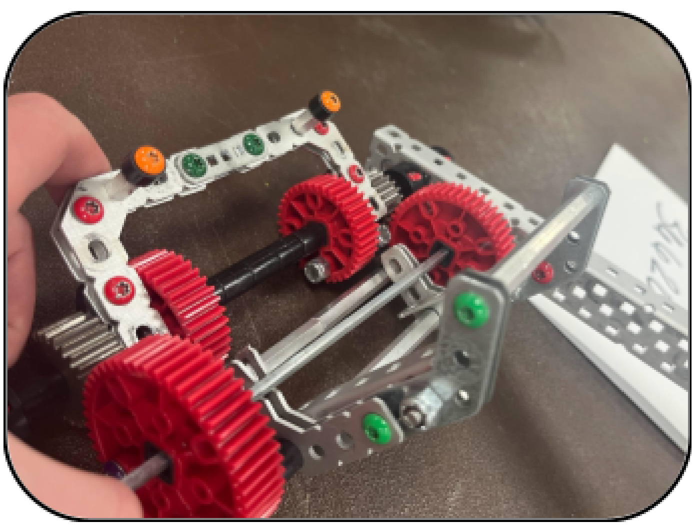
- Uses c channel 4 bar to lift the goal off the ground
- Keeps goal parallel to the ground



Positives	Negatives
• Can hold a lot of weight • Retracts into the robot- cannot be stolen	• Slow cycle times • Doesn't tilt goal- harder to put rings on

Prototyped Solutions

Clamp prototype



Claw prototype

Select and Plan

Game object Manipulation

Goal

Test and Select the solution that is best for the robot so we can plan how to build it.

Prototype Testing

Test 1: pickup strength

Test procedures:

1. Place prototype on field
2. pick up a goal
3. Try and dislodge goal by pulling in various directions
4. Observe if the goal fell out or not
5. Record observations

Results measured in success out of 5

Trial	1	2	3	4	5
Clamp	3/5	2/5	3/5	2/5	4/5
Claw	4/5	5/5	3/5	4/5	4/5

	Clamp	Claw
Average	2.8	4
Range	3	3

Most success: Claw
Most consistent: tie

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Test 2: pickup endurance

Test procedures:

1. Place prototype on field
2. Place a goal securely in the prototype
3. Place 6 rings on the goal
4. Observe the distance the goal has moved closer to the ground
5. Record observations

Results measured in inches (rounded to nearest 1/16”)

Trial	1	2	3	4	5
Clamp	.125	.0625	.0625	.125	.0625
Claw	0	.0625	.0625	.125	0

	Clamp	Claw
Average (lower is better)	0.0875	.0675
Range (lower is better)	.0625	.125

Most success: Claw

Most consistent: Clamp

Test 3: Pickup speed

Test procedures:

1. Put prototype on field
2. Start a timer
3. Grab a goal
4. Stop timer once goal has stopped moving
5. Record data

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Results measured in Seconds

Trial	1	2	3	4	5
Clamp	.326	.301	.350	.342	.455
Claw	.638	.663	.652	.791	.721

	Clamp	Claw
Average (lower is better)	.3548	.693
Range (lower is better)	.154	.083

Most success: Claw
Most consistent: Claw

Decision matrix - GOM

Strength	How tight of a hold the design has on a goal
Speed	How fast the design can pick up a goal
Endurance	How consistent the design holds a goal full of rings

	Strength	Speed	Endurance	Total
Clamp	3	5	3.5	11.5
Claw	5	3	4	11

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Test solution

<u>Game object Manipulation</u>

Goal	Test the solution so that we can see if it meets our requirements and goals

Test 1: pickup strength

Test procedures:

6. Place prototype on field
7. pick up a goal
8. Try and dislodge goal by pulling in various directions
9. Observe if the goal fell out or not
10. Record observations

Results measured in success out of 5

Trial	1	2	3	4	5
Clamp	3/5	2/5	3/5	2/5	4/5

Test 2: pickup endurance

Test procedures:

6. Place prototype on field
7. Place a goal securely in the prototype
8. Place 6 rings on the goal
9. Observe the distance the goal has moved closer to the ground
10. Record observations

Results measured in inches (rounded to nearest 1/16”)

Trial	1	2	3	4	5
Clamp	.125	.0625	.0625	.125	.0625
Claw	0	.0625	.0625	.125	0

Test 3: Pickup speed

Test procedures:

6. Put prototype on field
7. Start a timer
8. Grab a goal
9. Stop timer once goal has stopped moving
10. Record data

Results measured in Seconds

Trial	1	2	3	4	5
Clamp	.326	.301	.350	.342	.455
Claw	.638	.663	.652	.791	.721

- Be able to successfully grab the goal 100% of the time Success
- Be able to position the goal in the correct spot to put rings on Success
- Be able to last the entire match TBD

Conclusion

Even though we have achieved our goals, there is still room to improve on our design and we will be planning to revise this mechanism soon as we are confident it will work but not sure if it will last the whole match as we do not currently know how much we will have to use it.

Alec Tackitt 8/8/2024

Identify Problem

Game object manipulation II

Goal

Identify the objective of the previous solution so that we can brainstorm a solution to the objective

Problem Statement

We need a effective, quick, and reliable way to transport the rings onto the goal

Solution Requirements

- Must use legal Vex Robotics Competition parts
- Must fit within the 18”x18”x18” starting cube
- Must use no more than 11 Watts of motor power

Solution Goals

- Be able to successfully intake a ring 100% of the time
- Be able to place the ring in the goal 50% of the time
- Be able to fill the goal in 1 minute

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Brainstorm solutions

Game object Manipulation II

Goal	Brainstorm possible solutions to manipulating game objects so that we can select the best ones to prototype for the team.

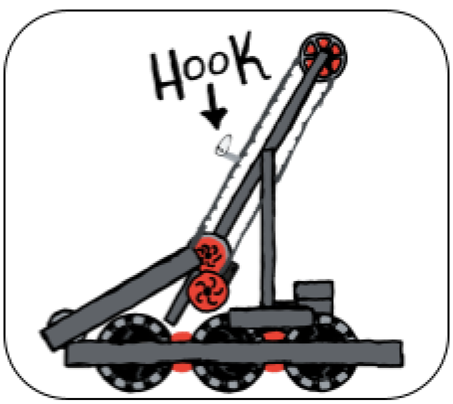
Possible solutions - game object manipulation

Since our design didn't work we decided to develop our second best prototype: the catapult. This will also include developing an intake for the catapult.

Here is the brainstorm design and data for the catapult again.

Hook conveyor

- Intake to pick up rings
- Chain with spaced hooks on it



Positives	Negatives
• Furthest range • Fast cycle times • Easy to control	• More complicated/easier to break • Chance of carrying 2 or more Rings • Not as easy to get Rings perfect on the goal every time

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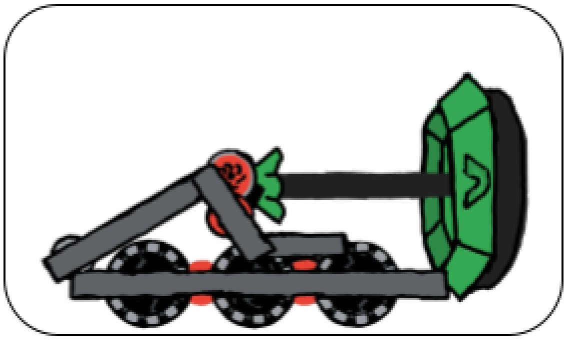
Flat intake

- More traditional style of intake
- Have flex wheels / conveyor above the rings



Positives	Negatives
• Familiar design • Faster intake RPM	• Heavier • Chance of carrying more than 2 rings • Not as easy to get rings in goal

(Select and) Plan

Game object Manipulation II

Goal Plan out a catapult in drawing and CAD to build and test.

Test 1: pickup rate

Test procedures:

1. Place prototype on field
2. Place ring in front of intake
3. Run intake for 5 seconds
4. Observe if ring was successfully picked up
5. Record data

Results measured in success out of 5

Trial	1	2	3	4	5
Hook	3/5	3/5	2/5	3/5	2/5
flat	2/5	3/5	4/5	2/5	3/5

	Hook	Flat
Average (higher is better)	2.6	2.8
Range (lower is better)	1	2

Test 2: Scoring rate
Test procedures:

1. Place prototype on field
2. Place Ring in intake and place a goal in a appropriate scoring position
3. Run intake until Ring has been ejected from intake
4. Observe if the ring was or wasn't scored on the goal
5. Record observation

Results measured in success out of 5

Trial	1	2	3	4	5
Hook	3/5	4/5	4/5	3/5	3/5
Flat	2/5	3/5	3/5	2/5	2/5

	Hook	Flat
Average (lower is better)	3.4	2.4
Range (lower is better)	1	1

Test 3: Pickup speed
Test procedures:

1. Put prototype on field
2. Start a timer
3. Position a goal under the intake
4. grab/intake 2 rings
5. Wait until there is only 1 ring in possession
6. Repeat 3-4 until a goal is full
7. Record how long it took to fill the whole goal

Results measured in Seconds

Trial	1	2	3	4	5
Hook	45	42	67	53	47
Flat	62	55	63	52	67

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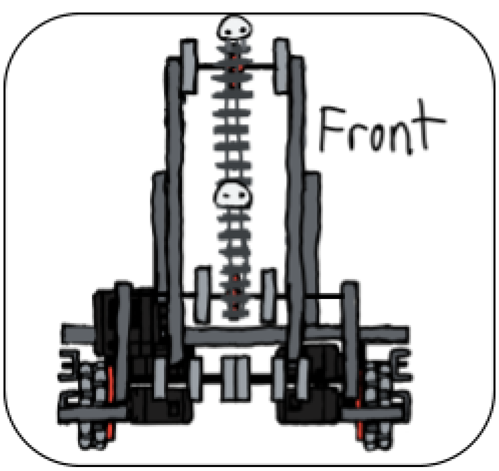
	Hook	Flat
Average (higher is better)	50.8	59.8
Range (lower is better)	25	15

Decision matrix - GOM

Speed	How fast the design can score rings
Accuracy	How consistent the design scores rings
Reliability	How consistent the design intakes a ring

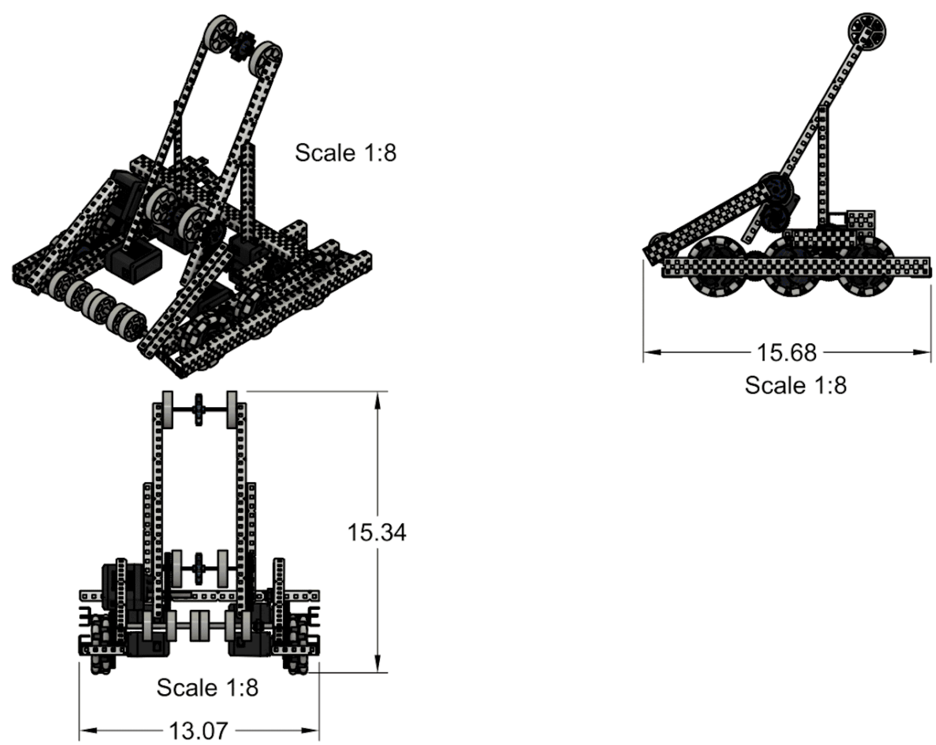
	Speed	Accuracy	Reliability	Total
Hook	4	3	3.5	11.5
Flat	3	2	5	11

Sketch Plan



Cade Peters 8/11/2024

Cad Plan



Item	Quantity	Part #
Sub 2.2 (right)	n/a	1
Sub 2.1 (left)	n/a	2
assorted angle channel	n/a	3
assored c-channel	n/a	4
assorted fasteners	n/a	n/a
assorted nylon spacers	n/a	n/a

PROJECT
36620B Robots

TITLE
Robot CAD
Drivetrain BOM

APPROVED	SIZE A	CODE	DWG NO	REV
CHECKED				
DRAWN alec tackitt	SCALE 1:8	WEIGHT	SHEET 1/2	

Alec Tackitt 8/13/2024

Alec Tackitt 8/15/2023

PARTS LIST	
QTY	PART NUMBER
1	1_2" HEX BORE PLASTIC VERSAHUB V2 (217-8079) V1
1	217-8079-001 OVERMOLD REV1
1	217-8079-001 OVERMOLD REV1
1	217-8079-001 OVERMOLD REV1 (1)
2	SPROCKET-HS-18-T OOTH
1	CHAIN
24	CHAIN LINK
1	LEXAN RAMP

PARTS LIST	
QTY	PART NUMBER
2	STANDOFF V1 (5)
2	90-DEGREE GUSSET ANGLE
1	2X C-CHAN ALU V1 (8)
2	STANDOFF V1 (6)
1	INTAKE
2	2X C-CHAN ALU V1 (9)
2	1X1 ANGLE ALU V1 (7)
4	STANDOFF V1 (7)
1	MOTOR
2	276-3524
2	1X1 ANGLE ALU V1 (1)
2	3 OD STRAIGHT FLEX WHEEL (217-6447)
2	6T HIGH STRENGTH SPROCKET (276-3876)
1	2 OD STRAIGHT FLEX WHEEL (217-6353)
1	1_2" HEX BORE PLASTIC VERSAHUB V2 (217-8079) V1 (1)
1	217-8079-001 OVERMOLD REV1 (1)

PARTS LIST	
QTY	PART NUMBER
1	CATAPULT
1	CATA TOWER
2	2X C-CHAN ALU V1 (6)
1	MOTOR
3	276-3524
1	HS 12T GEAR V1 (1)
1	HIGH STRENGTH 12 TOOTH PINION GEAR V1 (1)
1	HS METAL SHAFT INSERT (1)
2	ROUND INSERT (3)
1	HIGH STRENGTH 12 TOOTH PINION GEAR V1 (1)
1	HS 36T GEAR V1 (1)
2	SQUARE INSERT (1)
1	HIGH STRENGTH 36-TOOTH GEAR (1) (1)
2	ROUND INSERT (4)
3	HIGH STRENGTH 36-TOOTH GEAR (1) (1)
2	2X C-CHAN ALU V1 (7)
1	STANDOFF V1 (2)
1	1X1 ANGLE ALU V1 (6)

PROJECT
36620B Robots

TITLE
Robot 1, (no codename)

APPROVED	SIZE A	CODE	DWG NO	REV
CHECKED				
DRAWN alec tackitt	SCALE 1:6	WEIGHT	SHEET 2/2	

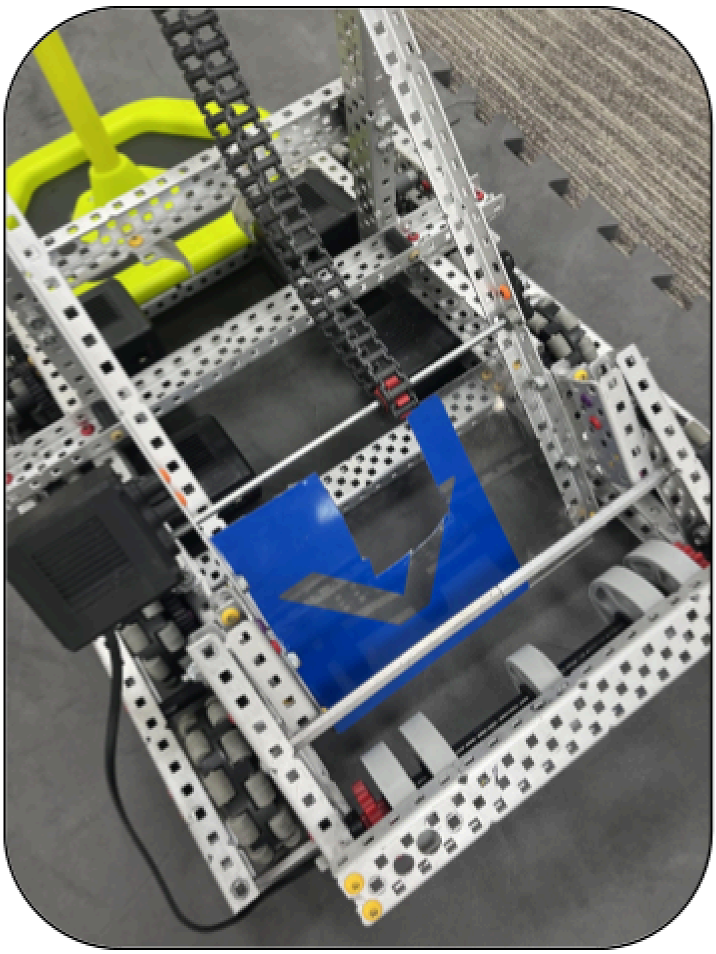
Build Solution

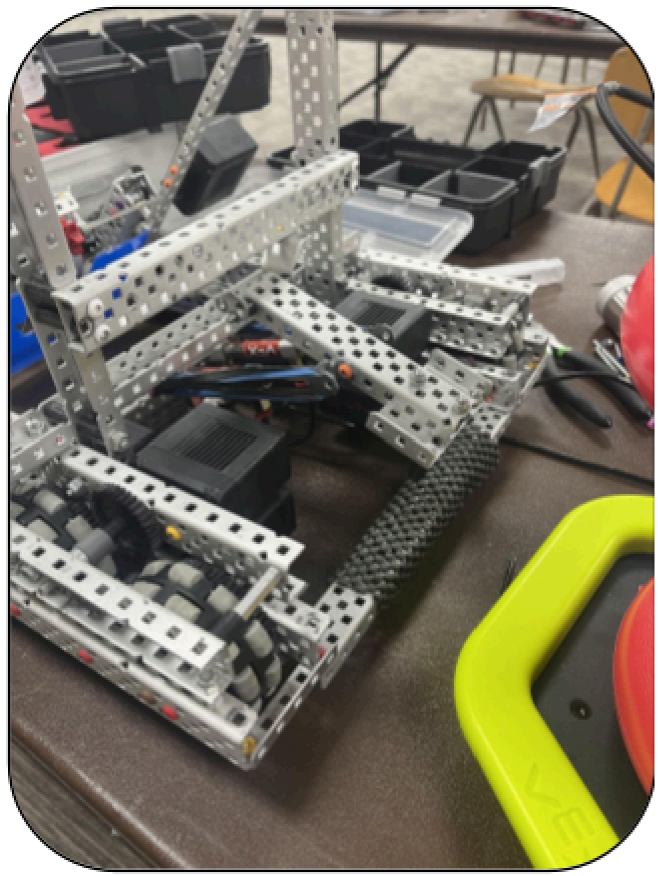
Game object Manipulation II

Goal

Build the planned solution so that we can test it's performance

Assembled Build





Cade Peters 8/16/2024

Test solution

Game object Manipulation II

Goal	Test the solution so that we can see if it meets our requirements and goals

Conclusion

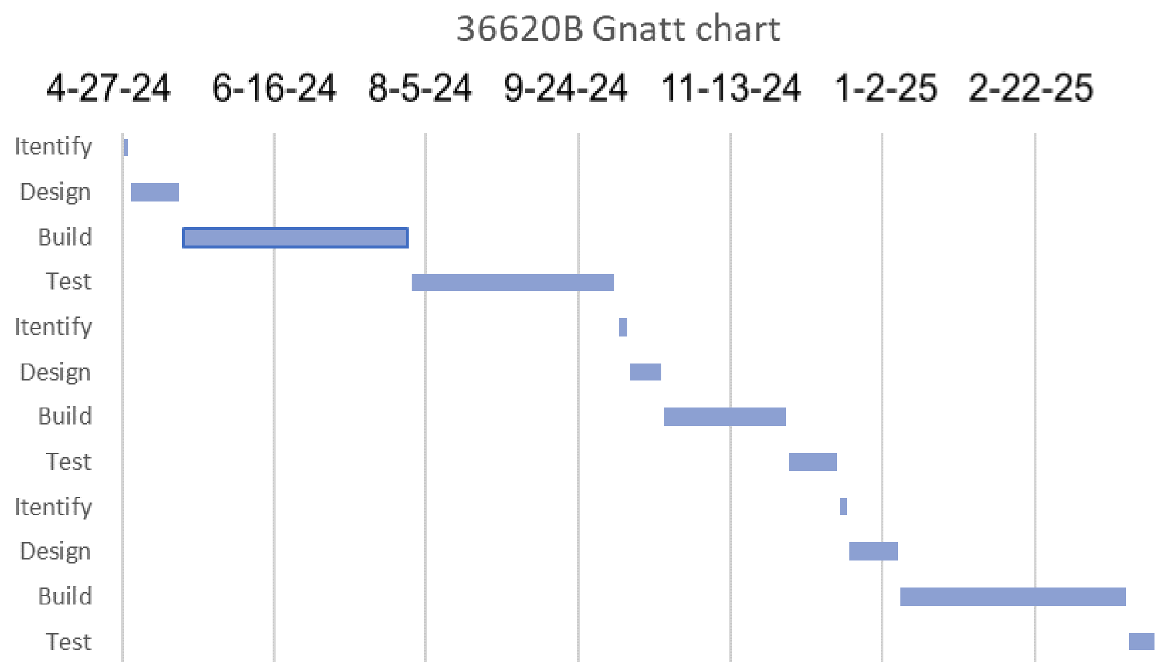
At the beginning of the testing we instantly noticed a problem: We could not test for more than 1 min and 20 ish seconds before the motor overheated. Due to the scale of the issue we decided to immediately stop testing and re-design the catapult

Alec Tackitt 8/18/2024

Gnatt chart

<u>Version 2 (9/20/2023)</u>

As stated before we planned to check in and potentially change our gantt chart frequently. As at our 1st practice we found out our mega league dates we decided to update our gantt chart accordingly.



Outline

We plan to use our 1st robot up until the Granville christmas tournament, this includes mega league, and a few tournaments that have yet to be listed on robot events so we just based the new chart after what we know.

Development for the 2nd robot: we plan to use it at the christmas tournament and riverbots if we get in, will start about 2.5 months before the tournaments, this gives us a few competitions with our competitors to test our robot to identify the flaws in our 1st robot.

Finally after riverbots we plan to develop our third robot for States if we have qualified already. If we have we will use our second bot at GTACS to allow more development time, on the other hand if we have not we will need to edit our gantt chart to accelerate the timeline to get our 3rd robot ready.

Alec Tackitt 8/23/2024

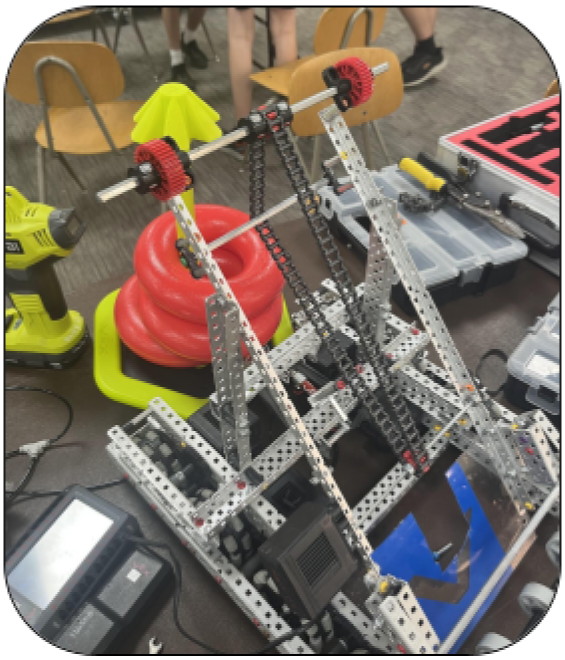
Build Solution

Full robot

Goal

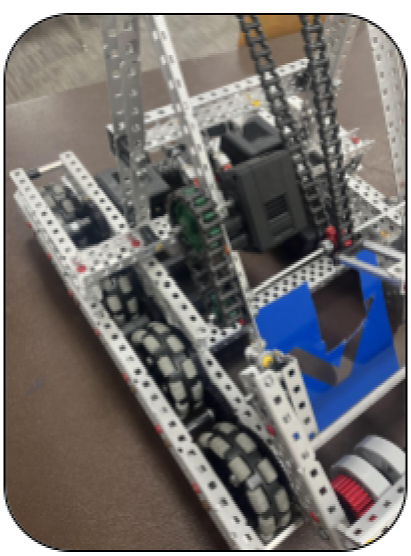
Build the planned solution so that we can test it’s performance

Assembled Build



Notes

The build went decently smooth again. We ended up replacing the mesh with rubber flex wheel due to the mesh not having enough compression. We also got the pneumatic tank mounted up for when we put pistons on the robot. We decided to put the license plates front/back so there is one on top of the intake. The next steps will be to code the robot and continue to progress the build with more features.



Note*
After a little testing we decided to chain the intake and the Conveyor together so that we can have a better efficient build fro our robot.

Cade Peters 8/25/2024

Test solution

Full robot

Goal	Test the solution so that we can see if it meets our requirements and goals

Test 1: pickup rate

Test procedures:

6. Place prototype on field
7. Place ring in front of intake
8. Run intake for 5 seconds
9. Observe if ring was successfully picked up
10. Record data

Results measured in success out of 5

Trial	1	2	3	4	5
Robot	3/5	4/5	4/5	3/5	4/5

Note: sometimes the triball went through the intake and bounced out of the cata, this was resolved later by lowering the intake speed. These instances were counted as successes

Test 2: pickup endurance

Test procedures:

11. Place prototype on field
12. Place a goal securely in the prototype
13. Place 6 rings on the goal
14. Observe the distance the goal has moved closer to the ground
15. Record observations

Results measured in inches (rounded to nearest 1/16”)

Trial	1	2	3	4	5
Clamp	0	.0625	.0625	.125	.1875

Test 3: speed

Alec Tackitt 8/27/2024

Test process

- Place prototype so that the back touches the wall
- Drive prototype around the field in a 3 lap “race”
- Start the stopwatch when the bot starts and end it when it has driven the 3 laps
- Record results

Table is in seconds (average lap time per race)

Trial	1	2	3	4	5
Robot	12.412	12.551	15.323	13.158	13.871

- Be able to successfully intake a ring 100% of the time Fail
- Be able to place the ring in the goal 50% of the time Success
- Be able to fill the goal in 1 minute Success
- Make a lap of the field in less than 15 seconds Fail
- Turn 360 Degrees in less than 1 second Success
- Be able to push a 15Lb robot Success

Conclusion

While we are proud of the successes of the robot it has not overall achieved all of our goals. There are many reasons we believe contribute to the shortcomings of the robot and plan to fix them as soon as possible, some of these shortcomings might require a full robot rebuild though so we will see if we can get a solution before our competitions.

Alec Tackitt 8/27/2024

Customization

<u>Custom plates</u>

This is a new heading we decided to add to give a place to all the customization to the robot we do over the season that we would like to share in the notebook. This time we vinyl cut custom text for our license plates. The goal of this was to make a more clean look on the license plates. We also attached our custom school license plate holders that Alec printed out for the High school teams.

Identify Problem

<u>Programming</u>

Goal

Identify our programming needs so we can choose the best way to program the robot

Problem Statement

We need a solid and capable way to code the robot to allow it to perform well, specifically in autonomous

Solution Requirements

- Must be in a Programming language the robot can read
- Must be able to code advanced algorithms and logic

Solution Goals

- Be able to create a successful base movement and control code
- Be able to have the ability to easily go to past versions of the code
- Be able to lay a foundation for more advanced coding

Alec Tackitt 9/6/2024

Brainstorm solutions

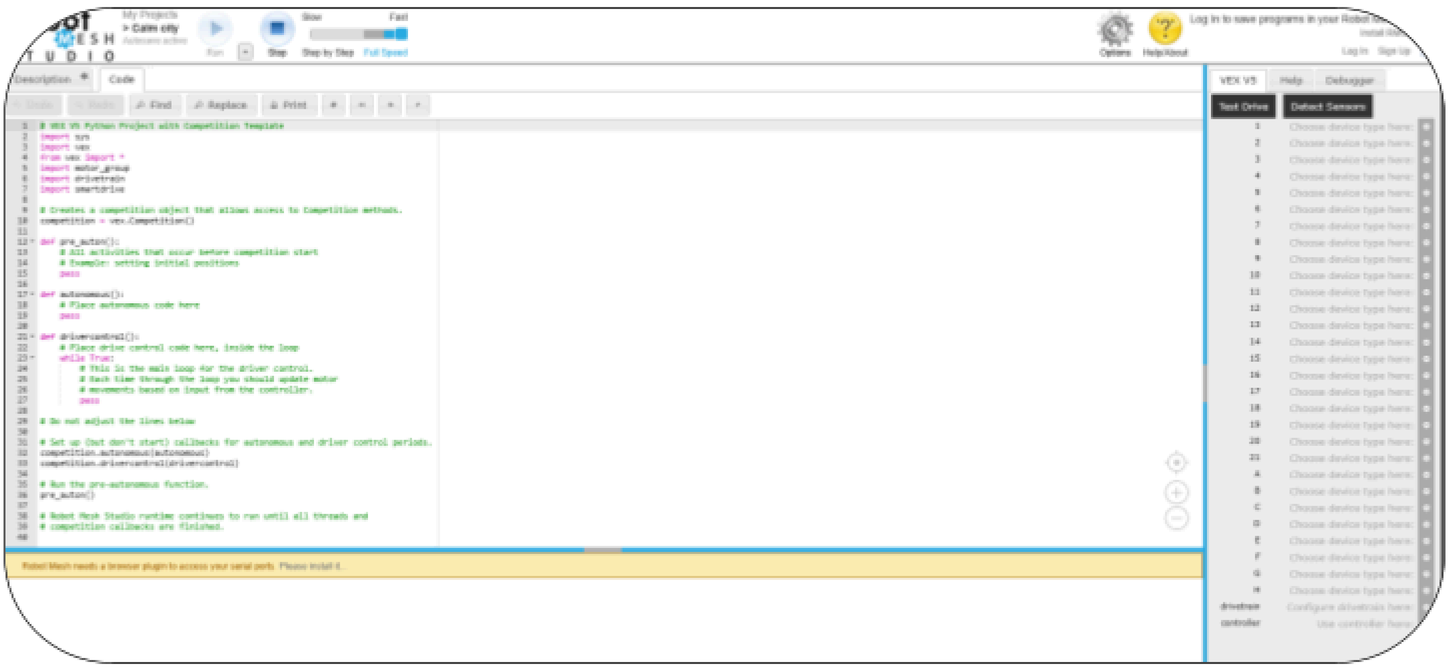
<u>Programming</u>

Goal	Brainstorm possible solutions on how to Program our robot so we can select the best one for the team

Possible solutions - Programming

RobotMesh Studio:

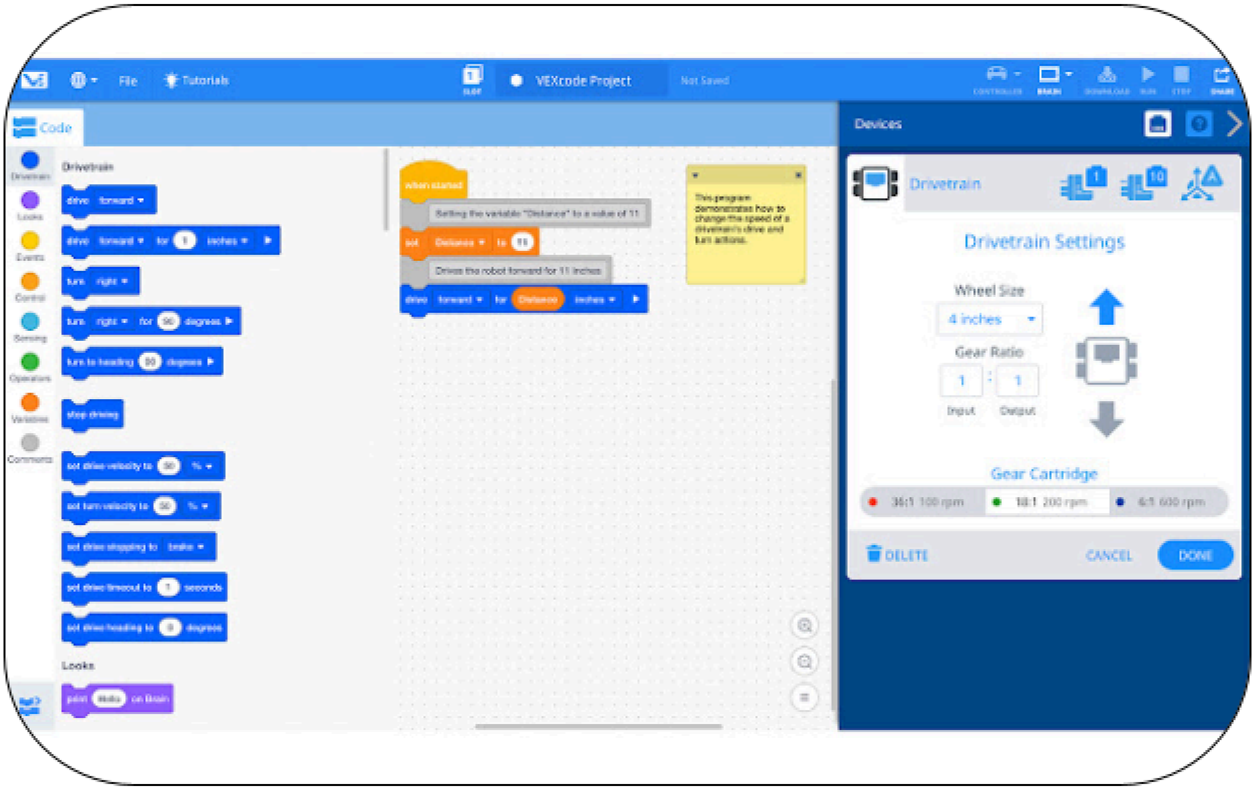
- Online based vex environment
- Simple and plain ui



Positives	Negatives
• User-Friendly Interface • web-based	• Limited Advanced Controls • Dependent on Internet Connection Alec Tackitt 9/6/2024

VEXcode V5:

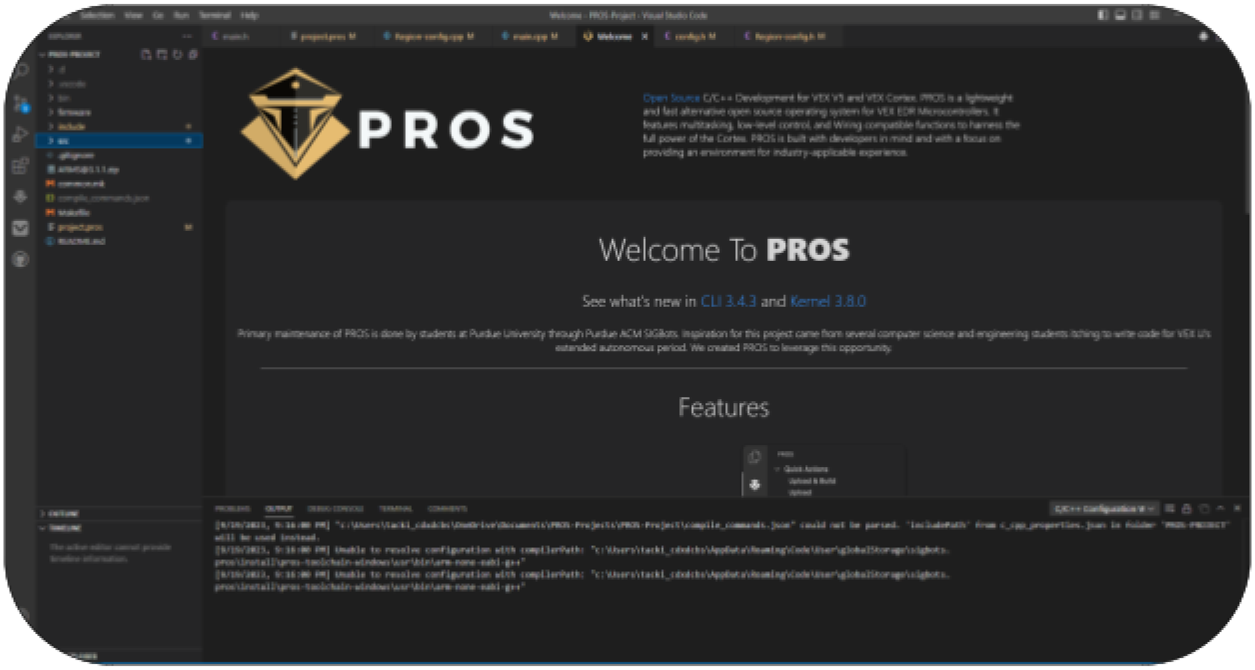
- Vex developed coding application
- Built on scratch



Positives	Negatives
• Official Vex support • Scratch IDE • Offline usage	• Limited programming methods • Less versatile and constrained

VSCode with PROS:

- Uses vscode IDE
- Extensions to make compatible with vex (PROS)
- PROS (Purdue robotics operating system) - full lightweight operating system for the v5 brain, new low level access and almost full control over the brain



Positives	Negatives
• **Full control** • Extensive customization • Version control and Git integration • Large wiki and community	• More options - bigger learning curve • Less beginner oriented • No official vex support

Alec Tackitt 9/7/2024

Select and Plan

Programming

Goal

Select the solution(s) that is best for the robot so we can plan how to integrate it.

Decision

We decided to use **VScode and PROS** for a few reasons.

1. The amount of access it gives us to the platform and robot hardware information
2. Pre made libraries to make it easier to code
3. An advanced challenge for us as we are no longer beginner programmers

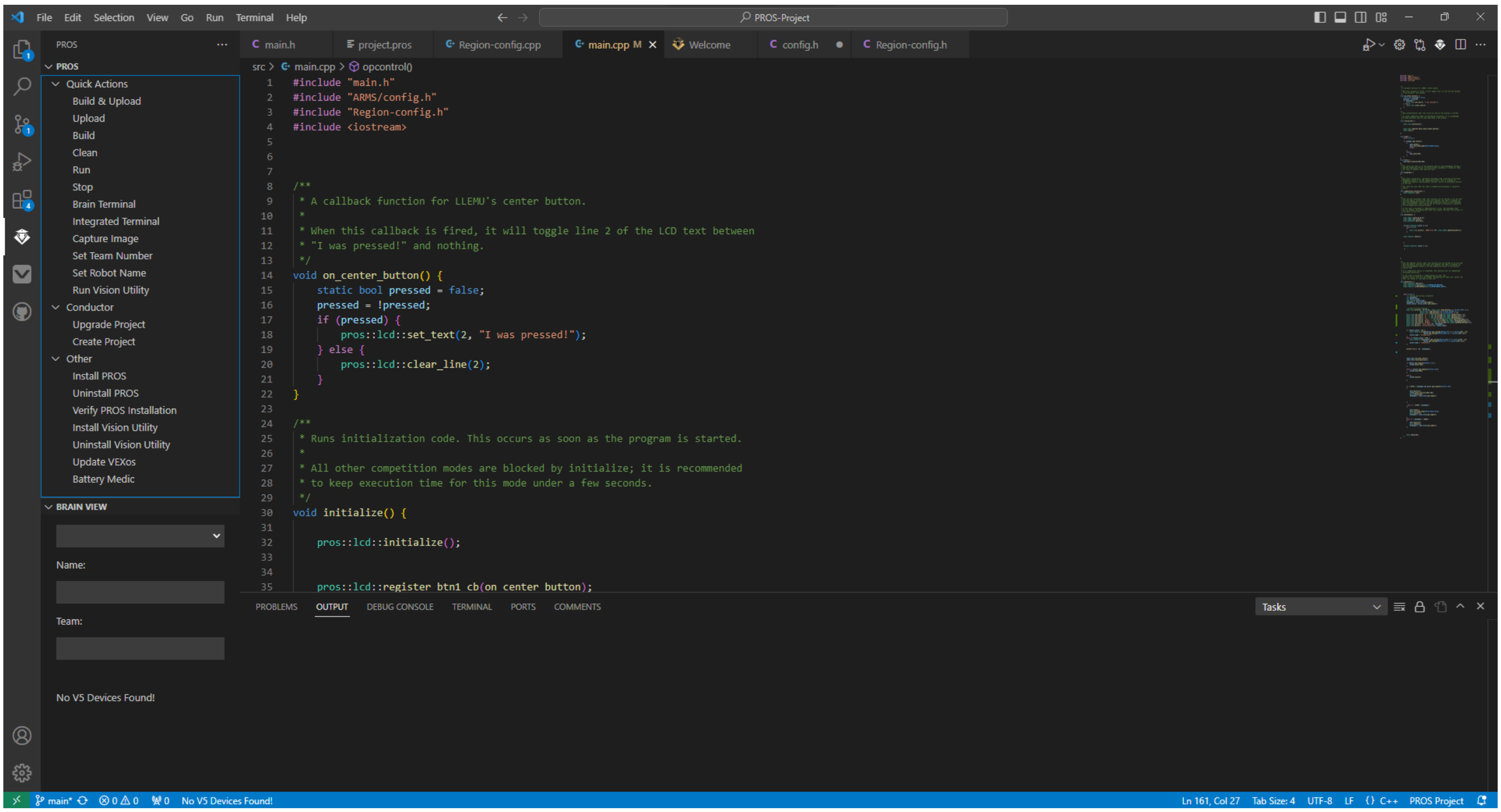
Along with this decision comes the decision of what language we will use. PROS is in strictly **C and C++** though, most of the cpp is an api or translation layer to C to make it easier to code. So we will be sticking to C++ for the foreseeable future.

Alec Tackitt 9/7/2024

Build Solution

Programming

Goal	Develop the solution so we can start some advanced coding



Here is the main screen after Alec got everything set up in VScode. We have our main code view which is on a PROS project starting template right now. The template just gets all the basic files and a skeleton code for the competition template. As we go on we may mention some significant features or opportunities with PROS but there is so much stuff and control that we could probably make a 500 page notebook on it all. So if anyone is interested in learning more about PROS we will have the links to the PROS docs and website here as well as a page at the front of the notebook. (if we remember to do it)

https://pros.cs.purdue.edu/v5/index.html (official docs)
https://pros.cs.purdue.edu/ (official website)
https://github.com/purduesigbots/pros (official Repository)

Alec Tackitt 9/7/2024

Github

As we noticed PROS was a github repository we decided to look into what it meant and how to put our code on Github. We found out a few advantages of this:

1. Version control
    a. At the end of every coding session or before a new one we could commit and push a stable version of our code to github along with a description of what we did. We do this to ensure we have a working version of our code at all times
2. Cloud storage
    a. As Github is hosted on the cloud we can access our code from anywhere and edit it, even with a phone via Github Codespaces, though to build and upload our code we will need to use VScode on a laptop. This feature also makes it easier if we ever have to use a different laptop, it is a few simple clicks and a password to have our code available from any device
3. Open source- public access
    a. With github we are able to make our code publicly available at https://github.com/Silentsword45/PROS-2025. Note in the readme: most of the code is from the Purdue sigbots team and Liam from lemlib so huge thanks to them for open sourcing their code.

These main points and a few smaller ones are why we decided to move our code to Github.

Alec Tackitt 9/7/2024

Test solution

Programming

Goal Test the solution so that we can see if it meets our requirements and goals

Conclusion

As this is just a decision of what environment to use to code there isn't much to test. So we just uploaded some simple driving and motor controls as well as testing printing to the brain and it all worked fine! Now we just have to see if it met our goals:

- Be able to create a successful base movement and control code Success
- Be able to have the ability to easily go to past versions of the code Success
- Be able to lay a foundation for more advanced coding Success

Alec Tackitt 9/7/2024

Identify Problem

Match Autonomous

Goal Identify our needs for autonomous period

Problem Statement

We need a specific route to follow for match autonomous

Solution Requirements

- Must be in a Programming language the robot can read
- Must be able to accomplish our designated route within the allotted time

Solution Goals

- Be able to score more than 5 points in match autonomous
- Be able to achieve an auton win point 100% of the time
- Use advanced coding techniques to speed up our autons

Alec Tackitt 9/8/2024

Brainstorm solutions

Autonomous

Goal

Brainstorm possible solutions to achieve our goals autonomously so we can select the best one for our team.

Note: we have decided to use specifically PID and odometry as we understand those concepts. Our solutions are mostly pre made libraries that can be used in PROS as using them saves us lots of time, though for the purpose of being able to debug and fix problems easily as well as competitive integrity **we have decided to only use libraries or parts of them that we understand as to not give us an "non-authentic" competitive advantage**.

Possible solutions - libraries

LemLib

- LemLib is a library for PROS and introduces advanced algorithms like pure pursuit and odometry, PID, Boomerang, and a path generator

Positives	Negatives
• Multiple expert level control algorithms • Easy integration	• Features are very complex • Need many sensors

ARMS

- ARMS is developed by the purdue sigbots
- ARMS introduces the advanced algorithms of PID, and odometry.

Positives	Negatives
• PID, odom, and boomerang integration • Experience using ARMS	• Lots of tuning • Doesn't have as many features as other options

Alec Tackitt 9/8/2024

EZ-template
- Plug and play with pros
- Very simple and easy

Positives	Negatives
• Plug and play • Minimal tuning	• Don't understand all the features • Not as in-depth docs

Possible solutions - routes

(Since we could note down so many different routes we decided to omit all of the non-optimal ones and only put the final routes here for the sake of keeping the notebook somewhat shorter.) Because of this we will not include the routes in the select and plan step.

Match

Close side
- Put match load under goal
- Clear preload from zone
- Lauch match load to other side
- Touch middle bar for AWP

Far Side
- Put match load under goal
- Go for close barrier triball
- Put triball under goal
- Go for middle barrier triball
- Put triball under goal

Skills

We will wait to plan skills auton as that is not as important as our upcoming events do not have skills

Decision

We have decided to use the Lemlib library as Alec has past experience using it and that it has more advanced features compared to the other programs.

Alec Tackitt 9/8/2024

Program Odometry

Goal Before we start programming our PID and actual Autonomous routes we need to program our odometry as it is how the robot knows where it is on the field.

Overview

Odometry is an algorithm/method the robot uses to figure out where it is on the field in terms of (x,y) and heading. By using 3 wheels (left, right, and middle perpendicular) we are able to use math to figure out how far the robot has moved and where it is.

Setup

Before we can get to doing any math we need variables to base it off of and tune them to get accurate results here are the main ones:

- TPI (ticks per inch)
    - We need this to accurately convert our x,y coordinates into x,y in inches
- Track width (width in between tracking wheels)
    - This measurement is used to more accurately determine heading as well as movement in the x direction when not using a middle wheel
- Left and right encoders
    - We need these values to find how far each side of the drivetrain has moved
- IMU heading
    - The heading provided by the IMU is crucial to find what direction we are heading and to increase or decrease x,y accordingly

Calculations

Now that we have some measurements we can calculate our robot's position with a few equations

Change in Robot Position:

Δx: Change in the robot's x-coordinate position.

Δy: Change in the robot's y-coordinate position.

Δθ: Change in the robot's orientation.

These changes can be calculated based on the distances traveled by each wheel:

$$\Delta x = \frac{d_L + d_R}{TPI} cos(\theta) \quad \Delta y = \frac{d_L + d_R}{TPI} sin(\theta) \quad \Delta\theta = \frac{d_L + d_R}{Track\ Width}$$

where θ is the current orientation of the robot and d_L and d_R are the distance traveled by the left and right side respectively, calculated by the ticks/TPI

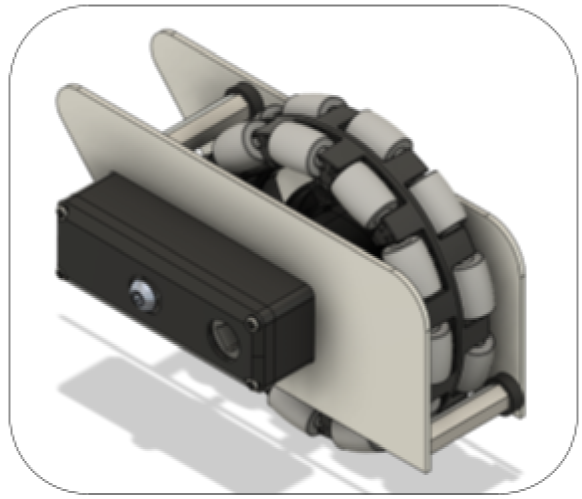
Now after we have the change in position we can calculate our new global pose, expressed in (x,y,h), with these simple equations:

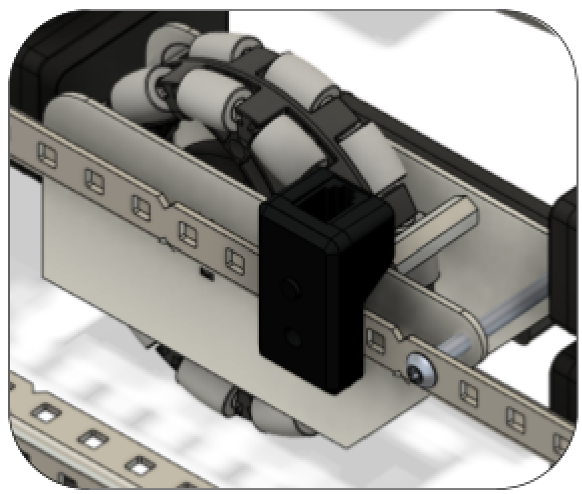
$$x_{new} = x_{old} + \Delta x \qquad y_{new} = y_{old} + \Delta y \qquad \theta_{new} = \theta_{old} + \Delta\theta$$

Alec Tackitt 9/9/2024

Though only using the 2 sides for figuring out position can be quite inaccurate due to gear slop, built in encoder inaccuracies, and most important for us is drift as we are on all omni wheels and can move side to side freely without moving the motors. Though thankfully we can use extra sensors to solve these problems.

Our solution





Our solution to these inaccuracies is twofold:

1. **Tracker wheel**
   a. We will implement an extra tracking wheel into our robot perpendicular to our drivetrain wheels to more accurately measure movement in the x direction.
   b. This simplifies our calculation for x movement to just:
   $$x_{new} = x_{old} + d_m$$
   Where d_m is just the distance traveled by the middle wheel.
2. **IMU**
   a. We attached an inertial sensor to the bottom of the robot to more accurately find our heading. This sensor directly gives us our heading instead of relying on math for it.
   b. This simplifies down our calculation for heading to just
   $$\theta_{new} = \theta_{old} + \theta_{IMU}$$
   Where θ_{IMU} is just the distance traveled by the middle wheel.

Recap

Odometry works by first finding new values for variables like left and right side drive movement, then calculates local or delta changes, and finally applies the delta changes to a global pose expressed by (x,y,h). These values can be more accurately read by extra sensors, in our case being a tracking wheel and an IMU.

Integration

We have decided to use the Lemlib library in PROS as it is quick and easy to set up, works consistently, and has a big support community if something goes wrong. Here are the links to the Lemlib repository and wiki for more information:
https://github.com/LemLib/LemLib/tree/stable
https://lemlib.readthedocs.io/en/stable/index.html

Alec Tackitt 9/9/2024

Program PID

Goal

Before we start planning our autonomous routes we need to tune our PID controller to get accurate results every time

Overview

PID is a feedback controller that allows for smooth acceleration and stopping as well as highly accurate results every time.

Important terms

- **setpoint** (SP): The desired target value or reference point that the system or process is intended to achieve.
- **Error** (e): The numerical difference between the setpoint and the process variable at a given time, indicating how far the system is from the desired state.
- **Proportional Contro**l (P): The component of the PID controller that produces an output proportional to the current error. It provides immediate corrective action.
- **Integral Control** (I): The component that addresses accumulated errors over time. It eliminates steady-state errors and brings the system to the setpoint.
- **Derivative Contro**l (D): The component that anticipates future error trends by considering the rate of change of the error. It helps dampen oscillations and improve system response.
- **Control Output** (CO): The corrective action or control effort applied by the PID controller to the system, such as adjusting motor speed or valve position.
- **Slew Rate**: The rate at which the control output is allowed to change, limiting abrupt or rapid adjustments to prevent instability or mechanical stress.
- **Steady-State Error**: The residual error that remains once the system has reached a stable state. Integral control is used to eliminate steady-state errors.
- **Anti-Windup**: A mechanism to prevent the integral component from accumulating excessive error when the system is at or near its limits.
- **Overshoot**: The temporary deviation of the process variable beyond the setpoint before settling to the desired value.
- **Undershoot**: The temporary deviation of the process variable below the setpoint before settling to the desired value
- **Response Time**: The time it takes for the process variable to reach and stabilize at the setpoint after a disturbance.

Alec Tackitt 9/10/2024

Setup

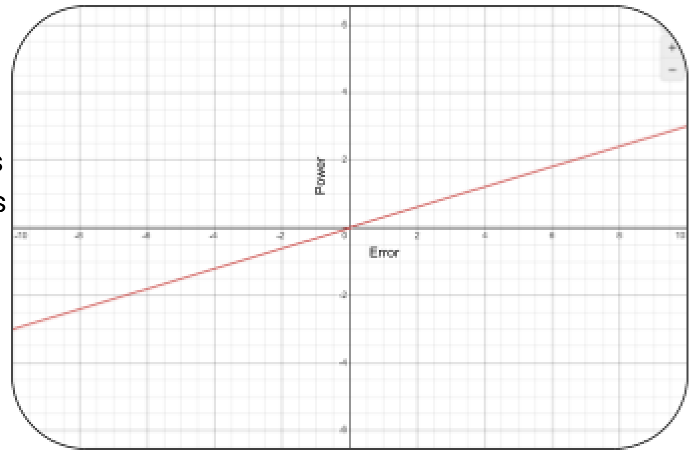
A PID controller has 4 main parts that work together to produce a smooth power output to whatever system they control in order to minimize error, in our case it is our drivetrain.

Error

Error is the difference between the desired value (setpoint) and actual distance measured by the motors. For example say we want to go forward 12”, we would define the setpoint as 12 and the PID loop would take the 12 and find the difference between the setpoint and the measured distance from the motor, resulting in an error of 12, algebraically expressed as: Error = setpoint -measured value or e= sp - mv. The PID component’s job is to make the error as close to 0 as possible, each part doing it a little differently.

Proportional - Kp

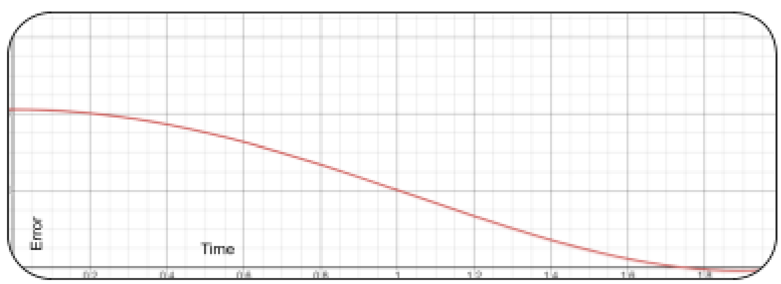
As the name suggests, this part of the loop outputs a value directly proportional to the error. It is the main power output for the system. We do this by simply multiplying e by a constant called Kp. this is algebraically expressed as: P = Kp * e, where P is our proportional output.



Integral - KI

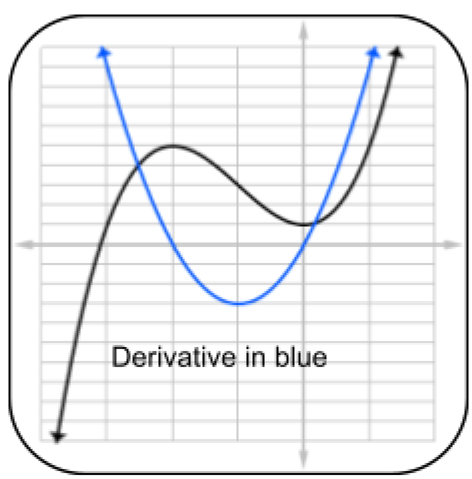
The integral addresses the build up of error over time. It is used to eliminate small steady state errors. This function evaluates the cumulative sum of the past errors and adjusts the output accordingly, mathematically it can be expressed as: I = Ki * $\int_{0}^{t} e(\tau)dr$

where I is the output, and $\int_{0}^{t} e(\tau)dr$ represents the error from the time 0 to t (or current).



Derivative

The derivative predicts future error by calculating the rate of change; it helps lower oscillation around the target and applies control effort based on how quickly the error is changing. Mathematically it can be represented as: D = Kd * $\frac{d}{dt}e$ where D is the output and $\frac{d}{dt}$ represents the derivative.



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Slew

Slew controls the rate of which the output is allowed to change. It is used to smoothen the curve of the PID loop.

Application

To use our PID loop we need to do 2 things

1. **Tune the loop**
    a. As Kp, KI, and Kd are all constants applied to their respective equations it is necessary to tune the constants to our specific system to do this we will be using the Lemlib tuning guide to change our constants- https://lemlib.readthedocs.io/en/stable/tutorials/4_pid_tuning.html
2. **Apply the values**
    a. Now that we have all the constants tuned we can simply use this equation: **speed = error * kp + *integral * ki + derivative * kd**; and apply speed as the velocity of the motors

Conclusion

Now that we have odometry and PID setup we can plan and make autonomous routes easily for both the current robot, and for any other robot with a little bit of tuning.

Note*

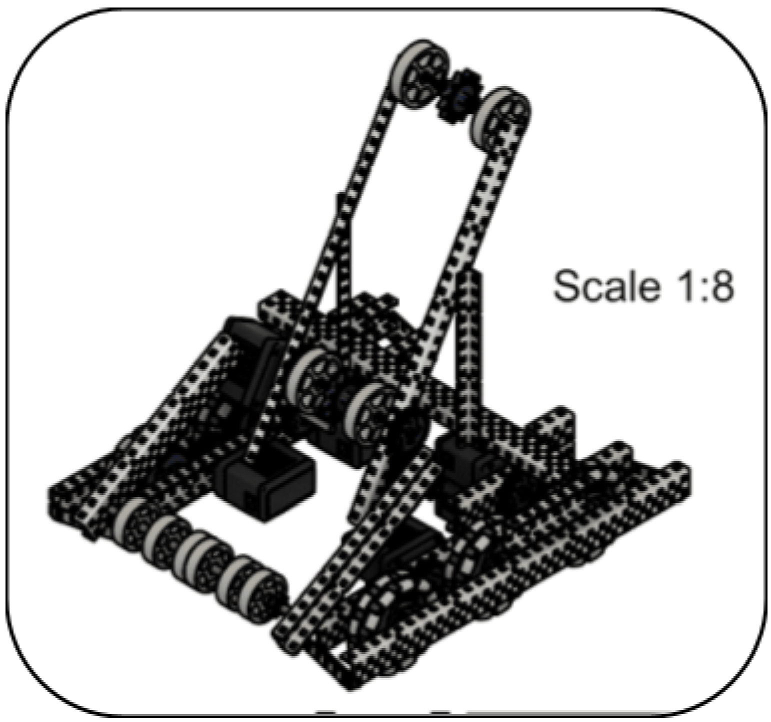
Due to lack of planning and lack of materials we were not able to add the tracking wheel to our current robot but plan to add it into the next bot/ revision of the current bot.

Alec Tackitt 9/10/2024

Render

Explanation

We decided to make a full render of our robot now that we have most stuff fully in CAD, so Alec played around with a few settings and the result turned out amazing This was just a fun little project on the side to take a break from the monotonous Odom and PID tuning and coding



Cade Peters 9/10/2024

Identify Problem

Auton Routes

Goal

We need a specific route to follow for both match and skills autonomous as well as a way to code them

Solution Requirements

- Must fit within allotted time limit (15 seconds for matches and 1 minute for skills)
- Must follow all the rules related to autonomous in the game manual

Solution Goals

- Be able to score more than 5 points in match autonomous
- Be able to achieve an auton win point 100% of the time
- Use advanced coding techniques to speed up our autons

Brainstorm solutions

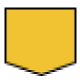
Autonomous routines

Goal	Brainstorm possible solutions on how to Program our robot so we can select the best one for the team

Decision

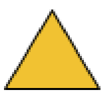
To keep the notebook condensed we decided to just include our decided routes and explanation.

Key



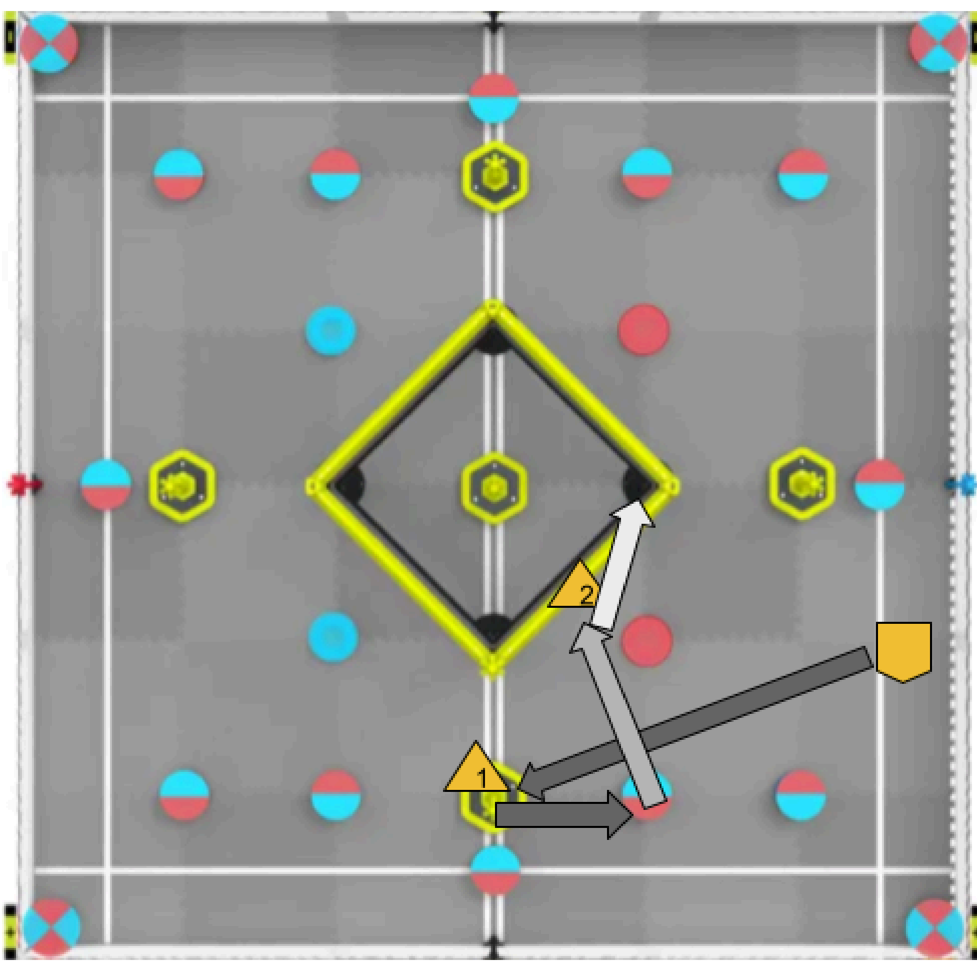
Starting point

Direction of robot travel, darker arrows are earlier in the program and lighter are later



Where a ring is scored, number indicates what triball it is in the routine, ex, 1st ring scored and 6th ring scored

Left side routine



Alec Tackitt 9/11/2024

Explanation

This is the route we are planning on taking when we are on the Left side, that being the left from the designated team's driver box, in this case being blue.

We plan on starting with our robot's back to the center goal, then go for center goal on the double line. We then pick it up, and put our preload ring onto it, after that we will go for the ring stack closes to the midline on our side, and intake our color ring. Then we will go to the goal that is on our side of the field closest to us and pick it up. Finally we will score the ring on the goal and go touch the ladder for auton win point

Right side auton

We will wait on deciding the right side autons for multiple reasons. First we want to see how well our program works before fully committing to it and we are also in a time crunch as our first competition is in a little over 2 weeks and would like to bring some hardware upgrades before then.

-

Alec Tackitt 9/11/2024

Select and Plan

Autonomous routines

Goal

Select the solution(s) that is best for the robot so we can plan how to integrate it.

Decision

We have already selected and planned out the steps in brainstorming to keep the notebook shorter.

Alec Tackitt 9/11/2024

Program Solution (pt 1)

Autonomous routines

Goal	Code the Program to use at competitions

Solution

As stated before anyone can view our code at:
https://github.com/Silentsword45/PROS-2025
But we also decided to include screenshots of our code in the notebook for those who don't have access to the repository for any reason

Left side Auton

```
 */
void autonomous() {
        // move to first goal
        chassis.setPose(x: 0, y: 0, theta: 0);
        chassis.moveToPose(x: 14,y: -59,theta: -30,timeout: 3000, params: {.forwards = false}, async: false);
        Claw.set_value(true);
        //move to rings
        chassis.moveToPose(x: 14.4,y: -46,theta: 10,timeout: 2000,params: {.forwards = true}, async: false);
        intake.move(voltage: -100);
        pros::delay(milliseconds: 1200);
        chassis.moveToPose(x: 17,y: -38,theta: 16.5,timeout: 3000,params: {.forwards = true}, async: true);
        pros::delay(milliseconds: 750);
        Claw.set_value(false);

        //move to second goal
        chassis.moveToPose(x: -2,y: -43.7,theta: 67.5,timeout: 2500,params: {.forwards = false}, async: false);
        Claw.set_value(true);
        pros::delay(milliseconds: 1000);
        chassis.moveToPose(x: -14,y: -49,theta: 60,timeout: 2000,params: {.forwards = false}, async: false);
        chassis.swingToHeading(theta: 67, lockedSide: DriveSide::LEFT, timeout: 500, params: {.maxSpeed = 60, .minSpeed = 20}, async: false);
        Claw.set_value(false);
        pros::delay(milliseconds: 250);
        intake.move(voltage: 0);
        chassis.moveToPose(x: -30,y: -45,theta: 270,timeout: 4000,params: {.forwards = true}, async: false);


}
```

Alec Tackitt 9/13/2024

Explanation

As stated before we decided to only do a left side auton, we feel like it works well enough although it has a few issues, one of which is crossing the middle line occasionally. Despite this we feel confident the auton will work for now, especially as this early in the season, not many people have one. We plan on revisiting the autons very soon to improve them and plan more.

Alec Tackitt 9/13/2024

Test solution

Autonomous routines

Goal Test the solution so that we can see if it meets our requirements and goals

Result

We will elaborate more in our 1st mega league recap, but the autons mostly worked with only 1 mishap and it was because we ran into another robot during auton. Other than that and not being able to complete our close side auton; we were pleased with the results of the autons.

Alec Tackitt 9/13/2024

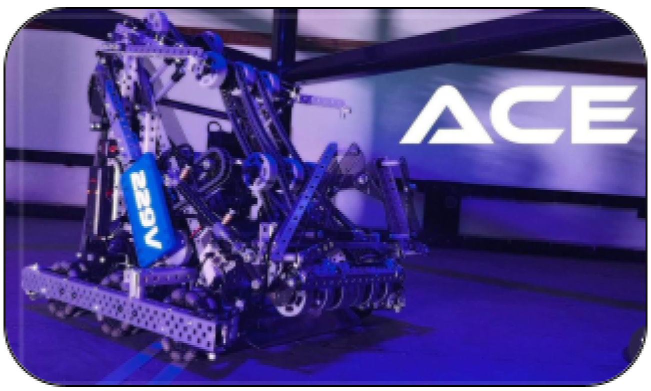
Team Inspection

229V

Goal

look at other teams and observe what makes their designs and strategies effective to better brainstorm solutions to our design and strategy

Robot Design



> **intake**
> low pivot point
> single roller
> flex wheels on belt

> **Clamp**
> pistons pushing down
> pistons attached in front of pivot
> **Wall stakes**
> single ring
> loaded from top of intake, expands out of the front

> Strategy
> quickly get and maintain a goal number advantage while protecting your positive corner
> only go for wall stakes if the positive corner is safe or are necessary

Key takeaways

- A quick and easy intake is important to be able to focus on other parts of the strategy
- Control of a positive corner is the most important thing

Cade Peters 9/13/2024

Team Inspection

11101B

Goal	look at other teams and observe what makes their designs and strategies effective to better brainstorm solutions to our design and strategy

Robot Design

> **intake**
	> low pivot point
	> single roller
	> flex wheels on belt

> **Clamp**
	> pistons pushing down
	> pistons attached in front of pivot

> **Wall stakes**
	> single ring
	> loaded from top of intake, expands out of the front

> Strategy
	> quickly get and maintain a goal number advantage while protecting your positive corner
	> only go for wall stakes if the positive corner is safe or are necessary

Key takeaways

- A quick and easy intake is important to be able to focus on other parts of the strategy
- Control of a positive corner is the most important thing

Cade Peters 9/13/2024

Identify Problem

Robot Rebuild

Goal

In accordance with our gantt chart and previous plans we will be identifying any major problems with our robot so we can either improve on the current design or make an entirely new one.

Problem Statement

Our old design was ineffective at securing a definitive lead because of the slow intake and difficult clamp design. We also don't have a way to score on wall stakes

Solution Requirements

- Must use legal Vex Robotics Competition parts
- Must fit within the 18"x18"x18" starting cube
- Must be lighter that 18 lbs

Solution Goals

- Have a easy to use clamp
- Have a 600 rpm intake
- Be able to effectively execute strategies (not hindering performance).
- Be able to score on wall stakes

Brainstorm solutions

Intake, Clamp, wall stakes

Goal

Brainstorm possible solutions to the systems mentioned above so we can effectively plan for building

Possible solutions - Intake

Flex wheels

- Add flex wheels to the top and bottom of the hook belt to allow for a more smooth transition on and off the belt

Positives	Negatives
• Increase reliability	• Doesn't increase speed

Blue motor

- Use a blue motor to increase the speed of the intake

Positives	Negatives
• Faster scoring •	• Easier to burnout • Less torque to pickup rings

Possible solutions - Clamp

Class 3 lever

- Pistons push the side of the clamp the goal is on

Positives	Negatives
• lighter • Easy to change	• Still shoots out back • No improvements to shooting

Class 1 lever

- Pneumatics are on opposite side of fulcrum as the goal

Positives	Negatives
• lighter • Easy to change	• Still shoots out back • No improvements to shooting

Possible solutions - Wall stakes

Lady Brown mech

- Take ring from top of intake and flip out top

Positives	Negatives
• lighter • Easy to change	• Still shoots out back • No improvements to shooting

Fish mech

- Take rings from the flat part of the conveyer and flip out the front

Positives	Negatives
• lighter • Easy to change	• Still shoots out back • No improvements to shooting

Select and Plan

Intake, Clamp, wall stakes

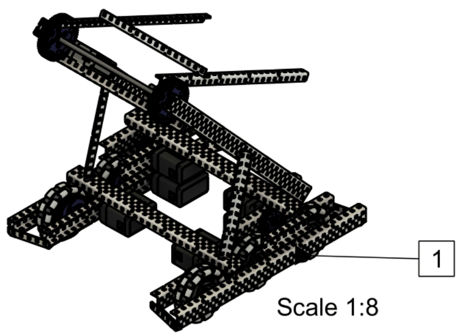
Goal

Select the Best solution for the robot so we can plan how to build it.

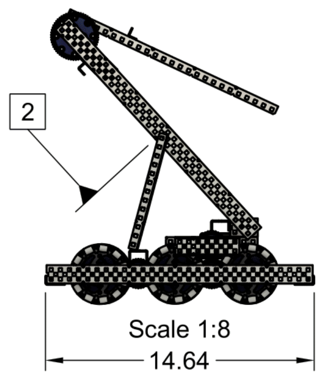
Decision-

Because of how complex it will be to replace both the intake and clamp, and add wall stakes, we decided to fully rebuild the robot as we would have to take apart the whole robot anyways. With this decision we also had to consider if we wanted to make any changes to the drivetrain, and we decided to stick with the same design, but removing a wheel to allow for more space to build mechanisms.

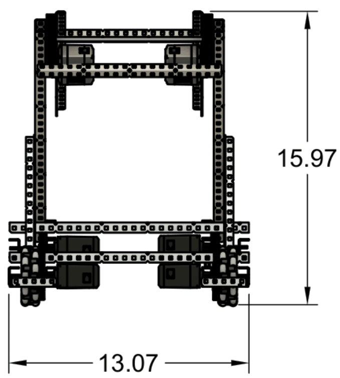
Cad Plan



Scale 1:8



Scale 1:8



Scale 1:8

Item	Quantity	Part #
Chassis	n/a	1
Lift	n/a	2
assorted fasteners	n/a	n/a
assorted nylon spacers	n/a	n/a

PROJECT
36620B Robots

TITLE
Robot CAD
Drivetrain BOM

APPROVED	SIZE	CODE	DWG NO	REV
CHECKED	A			
DRAWN alec tackitt	SCALE 1:8	WEIGHT	SHEET 1/2	

PARTS LIST	
QTY	PART NUMBER
1	CHASSIS
1	LEFT DRIVE SIDE
1	3.25 OMNI WHEEL V1 (1)
2	SQUARE INSERT (1)
2	ROUND INSERT (1)
1	3.25 INCH ONMI WHEEL (3)
3	LS 60T GEAR V1 (3)
2	3.25 INCH ONMI WHEEL (3)
3	LS 36T GEAR V1 (3)
3	276-4840
1	GEAR CARTRIDGE AND SHAFT (4)
1	MOTOR (3)
1	STANDOFF (.5")
1	C-CHAN ALU (10")
1	2X C-CHAN ALU V1 (2)
1	C-CHAN ALU (16")
1	C-CHAN ALU (16") (1)
2	1X1 ANGLE ALU V1
1	RIGHT DRIVE SIDE
1	LS 36T GEAR V1
1	LS 36T GEAR V1 (1)
1	C-CHAN ALU (16")
1	C-CHAN ALU (16") (1)

PARTS LIST	
QTY	PART NUMBER
1	3.25 OMNI WHEEL V1
2	SQUARE INSERT
2	ROUND INSERT
1	3.25 INCH ONMI WHEEL
1	3.25 INCH ONMI WHEEL (1)
1	276-4840
1	GEAR CARTRIDGE AND SHAFT
1	MOTOR
1	LS 36T GEAR V1 (2)
1	3.25 INCH ONMI WHEEL (2)
1	LS 60T GEAR V1
1	276-4840
1	GEAR CARTRIDGE AND SHAFT (1)
1	MOTOR (1)
1	LS 60T GEAR V1 (1)
1	LS 60T GEAR V1 (2)
1	276-4840
1	GEAR CARTRIDGE AND SHAFT (2)
1	MOTOR (2)
1	GEAR CARTRIDGE AND SHAFT (3)
1	C-CHAN ALU (10")

PARTS LIST	
QTY	PART NUMBER
1	2X C-CHAN ALU V1 (2)
2	1X1 ANGLE ALU V1
1	2X C-CHAN ALU V1
1	2X C-CHAN ALU V1 (2)
2	2X C-CHAN ALU V1 (12)

PROJECT

36620B Robots

TITLE

Robot CAD Drivetrain BOM

Parts list

APPROVED	SIZE A	CODE	DWG NO	REV
CHECKED				
DRAWN alec tackitt	SCALE 1:8	WEIGHT	SHEET 2/2	

Build Solution

Drivetrain and Game Object Manipulation Rebuild

Goal

Build the planned solutions that we notebooked before so that we can test it's performance

Note

With this rebuild we hope to be more thorough with our documentation so we will be trying to include more on the process of building the robot. To start, below is a Key on the lengths vs colors of the screws so when we reference the "red screw" it is easy to find what length we are talking about. We also will make sure to emphasize any deviations from the CAD plan that we had to make.

Screw length	Screw color
.290"	yellow
.375"	orange
.500"	red
.625"	Light green
.750"	Dark green
.875"	Light blue
1.000"	Dark blue
1.250"	Pink
1.500"	Purple
1.750"	White
2.000"	black
2.250"	Tan
2.500"	brown

Customization

Before we built it, Alec also decided to dye our gears to make for a sleeker look on the robot. To do this I simply put the gears, acetone, Rit dye, and water over an electric stovetop, and let them cook for a while. I learned this method from 60470S Semicolon, and they have an excellent video on youtube here: https://www.youtube.com/watch?v=C4ltH6-34Ps if anyone wants to learn more about the process.

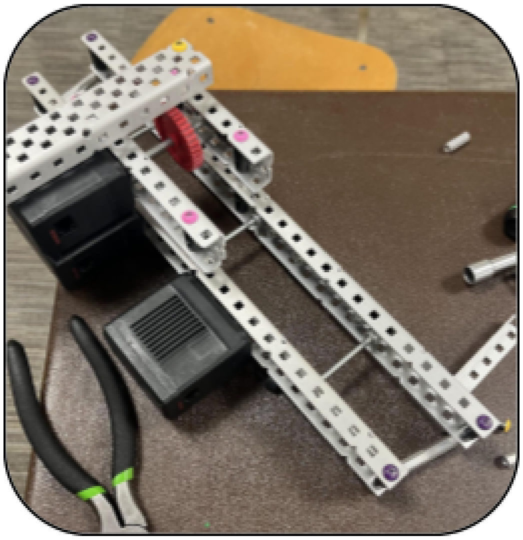
In the end the gears turned out a little bit darker than expected but still turned out great.

<u>Drivetrain Build</u>

This drivetrain took a very similar approach to the last one, just with one less wheel. We took time to ensure rigidity of the drivetrain at this stage, as after things are built on top of the drivetrain, if something goes wrong, it is extremely hard to fix. To do this we made sure every screw was properly boxed, and secured with nylock nuts, and all metal pieces were square to reduce problems with the drivetrain.

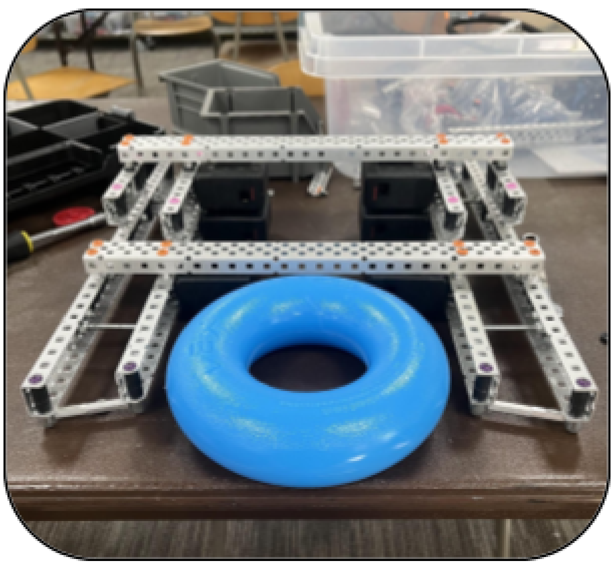
The assembly went smooth and we just had to make sure to follow the CAD and put bearing flats on the outside c-channel of where all the screw joints and axles are, and for the inside, nut retainers on the screw joints and the motors for the axles as the motors self-align the axles, all to reduce friction and minimize issues with the drivetrain.

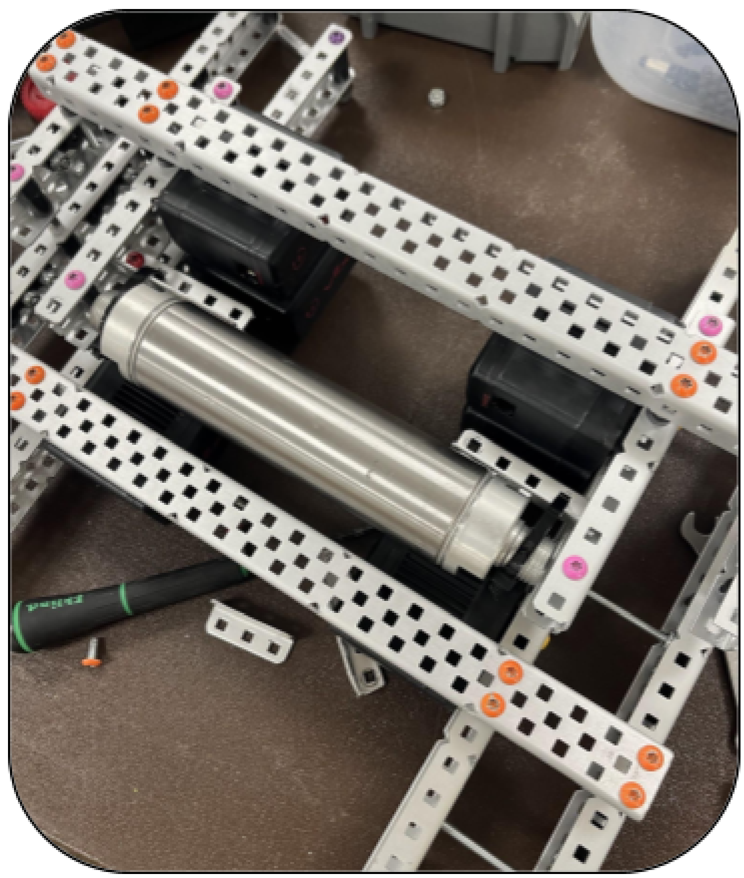
Alec Tackitt 10/19/2023



After making both sides we attached them together by loosely screwing the standoff braces and 1x1 braces together before Using a Speed square to ensure the robot is squared. This ensures there are no friction or misalignment issues with the chassis that could make building difficult or motors consume more power due to friction. We also test fitted the pneumatic tank and brain to make sure they fit well.

One thing we had to fix with the side braces is replacing the angle channel with standoffs to ensure proper spacing between the sides as the standard .5” holes don’t quite line up

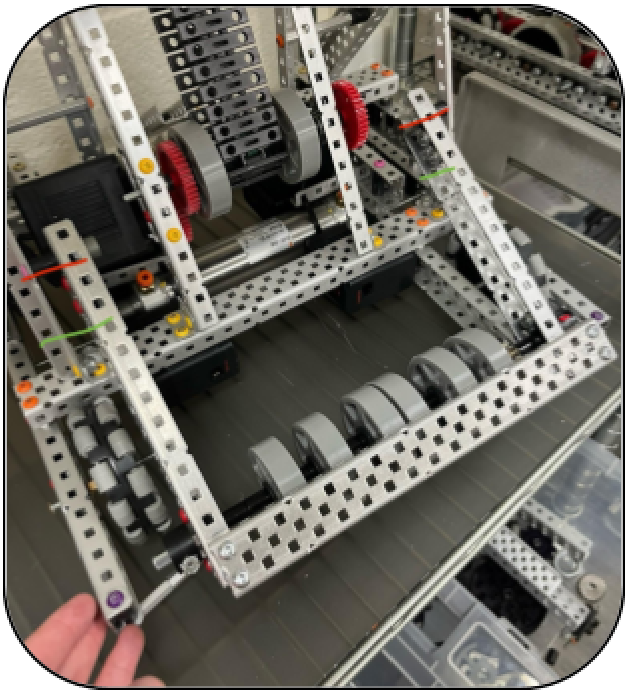




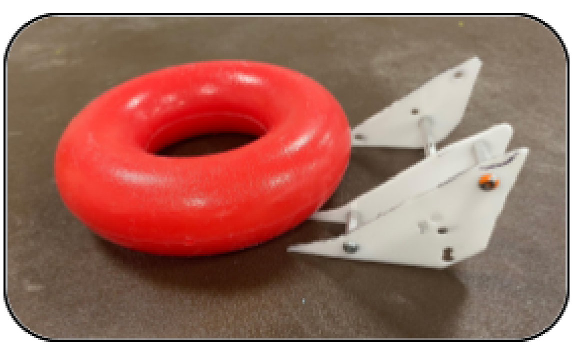
We then went ahead and mounted the pneumatic tank. To mount the tank we simply zip tied it to some 1x1 braces it hangs from.

Intake

Next we decided to build our intake as the claw position may change due to how far the Intake throws the ring and other variables.

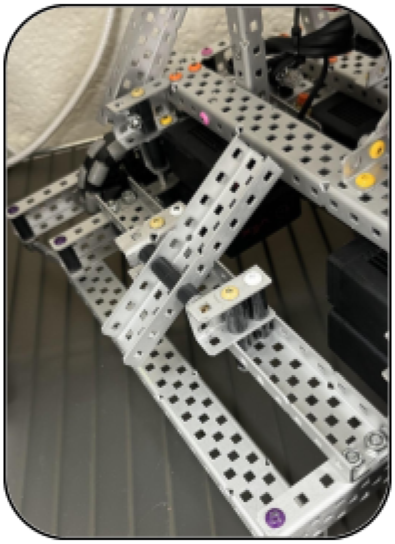


We started building the intake with the ramp and supporting structure, next we added the motor and belt to the ramp to make that portion of the intake work



After testing the second stage of the intake we made the first stage of the intake and the ramp to tune it to smoothly pick up the rings. **One unique thing we did with this ramp was to use the plastic on it's thin edge**, we did this as it would be easier to mount, as you can screw straight through the flat side, and easier to tune the angle, as you can just file away the edge At the same time we started building the structure for the lady brown mech to be able to score wall stakes.

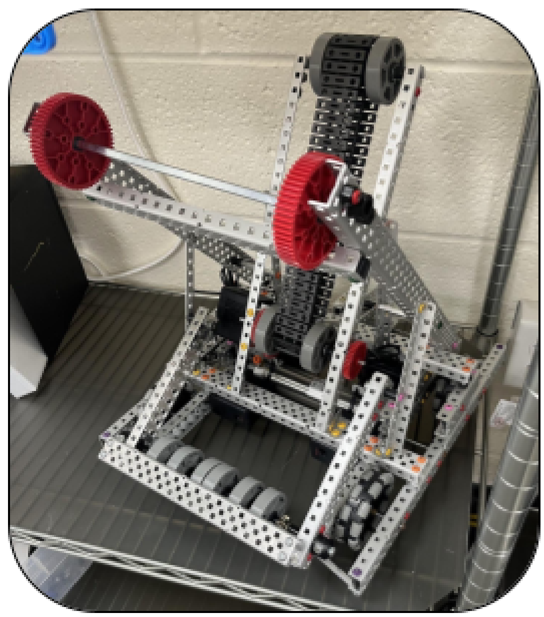
Next, we moved to building the clamp, this was probably the hardest part of the build as there was very limited space to work in.



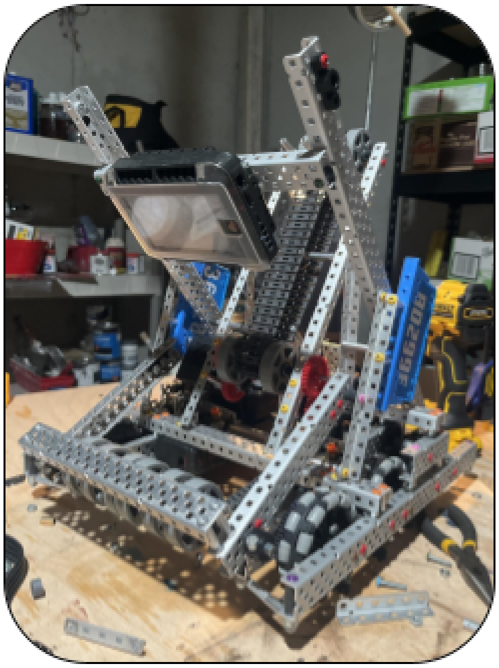
We used some new 25mm stroke pneumatics for the clamp as there was such little space in the robot for them. We did have to tune the exact position of the pneumatics and spacing on the clamp to get the angle and leverage we wanted, but eventually we got there.

Wall stakes

After quickly testing the intake and clamp to ensure it works together, we got to work on the wall stakes. We started with the supporting structure, attaching it to the intake and drivetrain to ensure it was rigid and wouldn't move from a big hit. After that we mounted the brain to a cross brace, as it is the most accessible part of the robot, to make it easy to use.



We started to build the wall stake mechanism but due to time constraints and tuning issues, we decided to forgo the mechanism for the time being, to allow us to prepare for upcoming competition. So instead we focused on making it competition ready, this included, final tuning, moving the battery mount, and attaching licence plate holders.



Finished(ish) bot

Although the robot Is not fully built, because of our upcoming competition we were forced to make a decision to either go to the competition with the old bot, or go with our incomplete new one. We decided, since the new one had all the functionality of the old one, we would use it since it would give us a good opportunity to test the robot and gather **data** in the real world.

Notes:

The Build went fast due to our good planning, the hardest part was the clamp as well as all the custom plastic pieces. Due to the smaller size it was harder to work in but we managed. A few changes we made from the CAD but nothing too major, mostly just spacing corrections or cosmetic pieces. We could not have completed this build without the pre-planning, design inspiration from teams like **229V, 11101B, and 18522R.** As well as build help and advice from **248A,B 244D**, and others. Overall we are excited to see how well it programs and performs at competitions.

Tournament Recap

Grandville Mega league night (10/3/2024)

Alec Tackitt 9/28/2024

Goal

We will observe our performance at the Mega league night so that we can Reflect on our shortcomings and plan for future success.

Match Results

Match	Red Alliance (Score)	Blue Alliance (Score)	Auton Bonus/AWP
Q1 (Loss)	248C, 36620B (3)	288D, 248A (9)	No bonus/no AWP
Q2 (Win)	216B, 216A (3)	244B, 36620B (11)	Bonus/no AWP
Q5 (Loss)	248A, 244B (11)	216B, 36620B (3)	No Bonus/no AWP
Q7 (Loss)	216A, 36620B (3)	248A, 248C (6)	No Bonus/no AWP
Q8 (Loss)	216A, 244B (15)	288D, 36620B (0)	No Bonus/no AWP

Final record: 1-4-0
League record: 1-4-0
League standing: 23rd

Takeaways

- **Q1**
  - In this match we got the first look at competition. Nobody could really do anything and we lost because they got 2 rings in autonomous.
- **Q2**
  - This match was much the same as the last, just this time our teammate could score rings slowly so we resorted to playing defence to keep the opponents off of our teammate.
- **Q5**
  - This match went much the same as Q2, but we were the team that couldn't score. Our ramp would dig into the field tiles, preventing us from moving forward and having to move backwards.

Alec Tackitt 10/3/2023

- **Q7**

    - This match was basically a repeat of Q1, they got 1 more ring in auton and won because of it
- **Q8**
    - We lost this match as neither of the bots on out alliance were able to score as we got disabled and the other bot got stuck on a ring
- **Robot Performance**
    - **Drivetrain**
        - + low friction and power usage
        - + faster than the opponents
        - - Was popping wheelies
        - - prone to driving up on rings
    - **Intake**
        - + easily sucked up rings
        - + didn't possess more than 2
        - - kept breaking and digging into field tiles
        - - struggled to pick up off the ground
    - **Clamp**
        - + Could hold onto the goals well
        - + efficient with air
        - - hard to line up in a match
        - - low clamping power

Conclusion

We were overall disappointed but were sort of expecting our result, we rushed out a robot that wasn't fully finished and got the result that reflected that. That being said we got a lot of advice from other teams as well as getting to see how our robot stacked up to the competition. We will now take the shortcoming that we observed and try to resolve them before the next competition.

Identify Fixes and Improvements

<u>Bot 2 rev 1</u>

Goal	Identify and fix small issues and improvements that we can make to the robot so we can move on to programming and practicing.

Chassis-

- Pops wheelies during fast acceleration and will drive itself onto rings and get stuck

Intake-

- Ramp was digging into the field tiles and the bottom stage would struggle to grip the ring.

Clamp-

- Worked pretty well, could have more force to prevent other bots pushing too hard on it. Pneumatic mount bent a little bit. Could also redesign to clamp from more angles.

Wall stakes-

- Didn’t have them.

Alec Tackitt 10/5/2024

Team Inspection

248B

Goal	look at other teams and observe what makes their designs and strategies effective to better brainstorm solutions to our design and strategy

Robot Design
> **intake**
    > low pivot point
    > single floating roller
    > traditional roller style

> **Clamp**
    > pistons pushing down
    > pistons attached in front of pivot
    > wide clamp

> Strategy
    > Fill up a goal as fast as you can
    > Maintain goal control and advantage

Key takeaways

- A quick and easy intake is important to be able to maintain a scoring lead
- Control of a positive corner, and majority goals is the most important thing

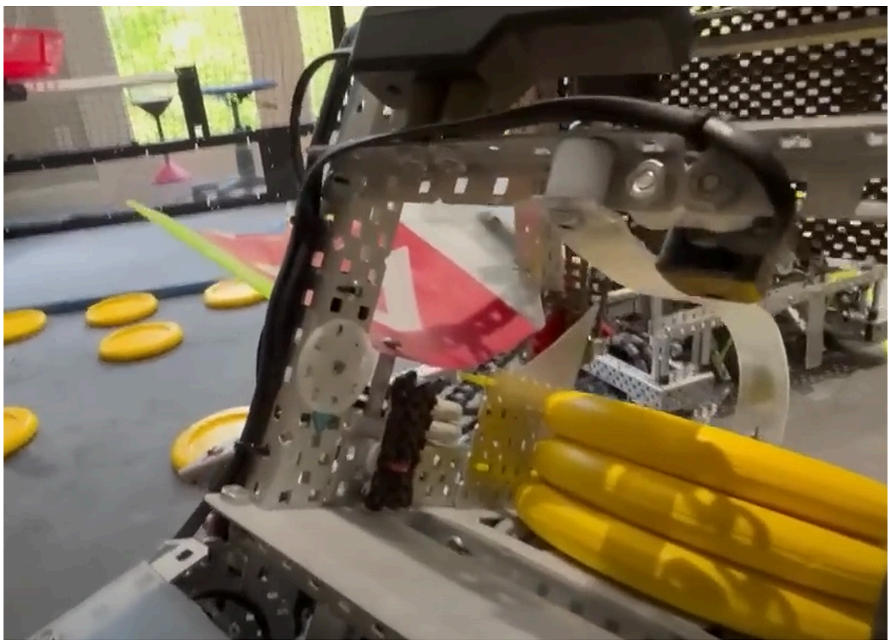
Alec Tackitt 10/5/2024

Team Inspection

515R

Goal — look at other teams and observe what makes their designs and strategies effective to better brainstorm solutions to our design and strategy

Robot Design



> **Pure Pursuit**

Efficient and advanced autonomous programming method for accurate auton routines

> **Auton Potentiometer**

Potentiometer to control auton selection, is fast and easy

Note

Although 515R's robot is not from this year we still wanted to include their bot as they have some cool mechanisms that weren't game specific that we would like to implement.

Alec Tackitt 10/5/2024

Tournament Recap

Hudsonville Christian Mega league night (10/14/2024)

Goal

We will observe our performance at the Mega league night so that we can Reflect on our shortcomings and plan for future success.

Match Results

Match	Red Alliance (Score)	Blue Alliance (Score)	Auton Bonus/AWP
Q2 (Win)	63600B, 36620B (25)	36620D, 61187C (0)	Bonus/no AWP
Q5 (Win)	32285A, 61187E (10)	32285B, 36620B (14)	No Bonus/no AWP
Q8 (Loss)	63600G, 36620B (3)	36620D, 63600H (6)	No Bonus/no AWP
Q9 (Win)	8031B, 36620B (17)	63600B, 61187E (5)	Bonus/no AWP
Q13 (Tie)	63600G, 36620B (3)	32285B, 8031B (3)	No Bonus/no AWP

Final record: 3-1-1
League record: 4-5-1
League standing: 32nd

Takeaways

- **Q2**
  - This match was good, our improvements worked ok and neither opponent could score.
- **Q5**
  - This match was closer, but with our strategy of our teammate playing defence on the opposing robot that could score, while we tried to score, we squeezed out the win.
- **Q8**

    - Our first loss of the night. The intake broke as the reinforcements we made broke, and the opposing team scored one more ring in auton. Our good defence after the intake broke prevented this from being a big loss for us.
- **Q9**
    - Another good win, neither of our opponents could score outside of auton so our teammate did a good job of defending us and we came out with the win.
- **Q13**
    - This match was a tie as our intake broke again, and since no one scored during auton, that was a tie and nobody could do anything during the match to get the win.
- **Robot Performance**
    - **Drivetrain**
        - + Decently agile
        - + Didn't burn out motors
        - - Was still popping wheelies
        - - not as much pushing power as some other robots
    - **Intake**
        - + Smooth scoring at the top
        - + Fast after picking up
        - - Ramp broke a few times
        - - struggled to pick up off the ground
    - **Clamp**
        - + Could hold onto the goals well
        - - hard to line up in a match
        - - Started to leak

Conclusion

Despite our relatively good performance, we still lost places in the league due to the fact that all teams have played now, and our first rough competition set us back a ways. With that being said we believe the robot is close to operating at its best and only has a few major issues left to fix.

Tournament Recap

Grandville Mega league night (10/22/2024)

Goal

We will observe our performance at the Mega league night so that we can Reflect on our shortcomings and plan for future success.

Match Results

Match	Red Alliance (Score)	Blue Alliance (Score)	Auton Bonus/AWP
Q2 (Loss)	36620B, 32285F (8)	288B, 2140E (9)	Bonus/no AWP
Q7 (Loss)	216M, 248B (24)	32285F, 36620B (6)	No Bonus/no AWP
Q13 (Win)	244C, 63600F (0)	36620B, 61187F (13)	Bonus/no AWP
Q23 (Win)	36620B, 288D (29)	32285C, 8860C (0)	Bonus/no AWP
Q30 (Win)	36620C, 2140B (6)	36620B, 98271A (13)	No Bonus/no AWP

Final record: 3-2-0
League record: 7-7-1
League standing: 27th

Takeaways

- **Q2**
    - This match we lost as we got stuck on rings trying to play defence on our opponents, despite this, the match was pretty close because of the auton bonus we secured.

- **Q7**
    - This match was similar the the first one, but we didn't get stuck on a ring, we went up against two tough opponents and tried our best but still lost
- **Q13**
    - Our first loss of the night. The intake broke as the reinforcements we made broke, and the opposing team scored one more ring in auton. Our good defence after the intake broke prevented this from being a big loss for us.
- **Q23**
    - Another good win, neither of our opponents could score outside of auton so our teammate did a good job of defending us and we came out with the win.
- **Q30**
    - Another win, nothing went too terribly wrong or good during this match, we just didn't play our best. Part of this was due to us having to go slow to avoid getting stuck on rings
- **Robot Performance**
    - **Drivetrain**
        - + Agile
        - + Didn't burn out motors
        - - Was still popping wheelies
        - - Getting stuck on rings
    - **Intake**
        - + Smooth scoring at the top
        - + Fast after picking up
        - - Ramp broke a few times
        - - struggled to pick up off the ground
    - **Clamp**
        - + Could hold onto the goals well
        - - hard to line up in a match
        - - Started to leak

Conclusion

We took back some of our places in the league this night, the performance was ok but we will need to do better next time as other teams continue to advance their design and skill. We also started to get more auton win point to help us in the standings.

Brainstorm solutions

Intake, Clamp, wall stakes

Goal	Brainstorm possible solutions to the systems mentioned above so we can effectively plan for building

Possible solutions - Intake

Flat Ramp

- Traditional ramp, using the flat side of sheet plastic
- Secure and bend using zip ties and heat

Positives	Negatives
• Familiar with design • Less friction	• Uses more plastic • Harder to tune angle

Possible solutions - Chassis

Expand wheelbase

- Longer distance between wheels, more wheels
- Prevents tipping by spreading weight around more

Positives	Negatives
• Effective • Increases grip and traction	• Will need almost a full rebuild • Makes the whole bot bigger Alec Tackitt 10/24/2024

Redistribute weight

- Move massive objects, like pneumatics tank lower to lower the center of gravity
- Prevents tipping by lowering the mass

Positives	Negatives
• Easier to implement • Quicker to implement	• Not as effective, not that many things to move • Makes the whole bot bigger

Possible solutions - Clamp

Angled lever

- Add a angle behind the pivot where pneumatics attach
- Increases leverage

Positives	Negatives
• Increases leverage • Stronger clamping force	• Takes up a lot of space

Wider lever

- Make the lever wider to increase area of the clamp
- Makes lining it up less precise, easier to use

Positives	Negatives
• Increases Usability • Wider pressure, increases clamp strength	• Takes up more space

Alec Tackitt 10/24/2024

Direct lever

- Attach pneumatics on side that the goal is on
- Efficient use of space

Positives	Negatives
• Easy to build	• Not the most mechanically strong

Select and Plan

Intake, Clamp, wall stakes

Goal

Select the Best solution for the robot so we can plan how to build it.

Decision-

Because of how complex it will be to replace both the intake and clamp, and add wall stakes, we decided to fully rebuild the robot as we would have to take apart the whole robot anyways. With this decision we also had to consider if we wanted to make any changes to the drivetrain, and we decided to stick with the same design, but removing a wheel to allow for more space to build mechanisms.

Tournament Recap

Grandville Mega league night (11/12/2024)

Goal

We will observe our performance at the Mega league night so that we can Reflect on our shortcomings and plan for future success.

Match Results

Match	Red Alliance (Score)	Blue Alliance (Score)	Auton Bonus/AWP
Q6 (Win)	36620B, 32285D (19)	36620E, 216J (4)	Bonus/no AWP
Q8 (Loss)	36620B, 216B (0)	63600C, 457B (15)	Bonus/no AWP
Q12 (Tie)	63633A, 97311B (3)	36620B, 2140B (3)	Bonus/no AWP
Q22 (Win)	36620D, 63633C (2)	36620B, 63600E (24)	Bonus/no AWP
Q25 (Win)	36620B, 248B (30)	63633B, 32285B (8)	Bonus/no AWP

Final record: 3-1-1
League record: 10-8-2
League standing: 27th

Takeaways

- **Q6**
    - This match we won as we were better able to score some wings on the mobile goals and secure them in the positive corner

- **Q8**
    - Our first loss of the night. The battery cable was not plugged into the battery all the way so once we started our robot lost power to the brain, so we were disabled for the rest of the match. Our teammates unfortunately did not have a working intake so they weren't able to score either

- **Q12**
    - We came into this match very confident that we would probably win, but our alliance and us got bully and pushed around a lot; making it very difficult for either of us to score. The match ended in a tie
- **Q22**
    - Another good win, neither of our opponents could score outside of auton so our teammate did a good job of defending us and we came out with the win.
- **Q25**
    - Another win, we worked very well with our alliance and we were able to easily score a few stakes and secure them in the positive corner

Robot Performance

- **Drivetrain**
    - + Agile
    - + Didn’t burn out motors
    - - Was still popping wheelies
    - - Getting stuck on rings
- **Intake**
    - + Smooth scoring at the top
    - + Fast after picking up
    - + Ramp was much more secure
    - - struggled to pick up rings off the ground fast
- **Clamp**
    - + Could hold onto the goals well
    - - hard to line up in a match
    - - Got bent after the first match

Conclusion

We took back some of our places in the league this night, the performance was better than last with our old robot but we will need to do better next time as other teams continue to advance their design and skill. We also started to get more auton win point to help us in the standings.

Tournament Recap

Grandville Holiday (12/7/2024)

Goal

We will observe our performance at the Mega league night so that we can Reflect on our shortcomings and plan for future success.

Match Results

Match	Red Alliance (Score)	Blue Alliance (Score)	Auton Bonus/AWP
Q12 (Win)	63600C, 36620B (26)	98271A, 8031C (14)	Bonus/no AWP
Q23 (Win)	3223C, 6581S (0)	36620B, 63600E (13)	No Bonus/no AWP
Q46 (Win)	36620B, 244A (40)	2581P, 98271E (3)	Bonus/AWP
Q59 (Win)	36620B, 98271C (29)	13444A, 21908A (25)	Bonus/AWP
Q77 (Win)	2140F 288D (18)	36620F 36620B (23)	Bonus/no AWP
Q93 (Win)	248B, 36620B (27)	63600A, 13444B (18)	Bonus/AWP
R16 1-1 (Win)	36620B, 244D (39)	63600F, 63600G (10)	Bonus/no AWP
QF 1-1 (Win)	36620B, 244D (40)	36620H, 288A (26)	Bonus/no AWP
SF 1-1 (Loss)	36620B, 244D (22)	248D, 288C (41)	No Bonus/no AWP

Final record: 8-1-0
Quali Ranking: 1st

Takeaways

- **Q12**
    - We started the day good with a win, pretty easily getting the auton bonus and going on to not make any major mistakes
- **Q23**
    - This match was a little bit different as we were the only team to be able to score. Due to that fact we faced a lot of defence, but only scoring a few rings was enough to win
- **Q46**
    - This was another match where our alliance was the only one to score, together with our teammates, we secured the auton win point and the match as well, boosting our rankings a lot.
- **Q59**
    - Another good win, despite our battery coming loose and disconnecting mid match, we won with the help of our teammates.
- **Q77**
    - Another win, our teammates were fun to play with, against some decent teams, but with some good defence, we won the match.
- **Q93**
    - Another strong alliance, we were able to easily secure the auton bonus and win point, and go on to win the match.
- **R16**
    - Coming out of alliance selection as the 1st ranked team has many advantages, and this was one. Our first match was pretty easy and we used it as a warm up for our upcoming matches.
- **QF**
    - With the practice of the first match to finalize our strategy, we were confident coming into the next playoff match. This ironed out strategy and confidence lead us to win this match against strong opponents.
- **SF**
    - This match was by far the highest skill and toughest match of the whole event, and the score shows that. We ultimately lost due to a blunder on our part, moving a goal where we shouldn't of and letting our opponents get another positive corner.

- **Robot Performance**
  - **Drivetrain**
    - + Agile
    - + No wheelies
  - **Intake**
    - + Smooth scoring at the top
    - + Ramp was consistent
    - - struggled to pick up off the ground
  - **Clamp**
    - + Could hold onto the goals well
    - - hard to line up in a match

Conclusion

With this good performance we left confident in our ability to perform well, although it would have been nice to get a state qualification from this tournament. The robot is coming together and only needs a few more things to be fully working.

Programming

Pure pursuit

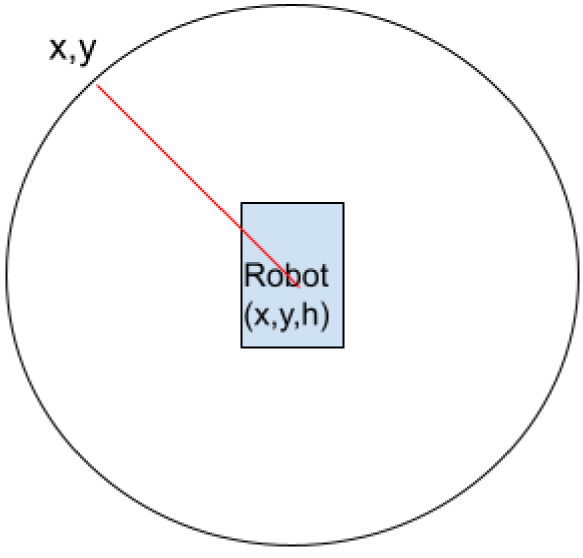
Goal

Develop a understanding of advanced algorithms

Notes: since it has been a while since our last new programming we decided to switch to using LemLib instead of ARMS as it allows us to use the pure pursuit algorithm to follow a set of coordinates on the field to allow for more accurate autons in the case of misaligned fields, motor errors, and hitting other robots. Pure pursuit also simplifies the coding process by allowing us to draw our paths with a simple path planner like the one found at https://path.jerryio.com/ and that takes care of all of our motor movements. So we only have to deploy our wings or move out intake to have a functioning auton routine.

A bit on how pure pursuit works

Pure pursuit is another control loop that gives feedback to our PID loop to allow the robot to move. The pure pursuit (PP) algorithm takes our current pose (x,y,h) and looks at a given point (x,y) around the robot on a unit circle like in the picture. Then it uses some simple trigonometry to find the angle (red line) it needs to turn as well as speed to get to that point exactly. It then gives this information to our PID controller to actually send the commands to the motors to move.



Tournament Recap

Hudsonville Christian (1/18/2025)

Goal	We will try to get a state qualifying award, and observe what we need to change about our robot for the next tournament.

Match Results

Match	Red Alliance (Score)	Blue Alliance (Score)	Auton Bonus/AWP
Q7 (Win)	36620F, 36620B (23)	49037W, 32285D (13)	Bonus/ AWP
Q13 (Win)	216F, 36620B (15)	32285A, 36620H (14)	Bonus/ AWP
Q22 (Win)	11591Y, 216B (0)	36620B, 36620C (40)	Bonus/AWP
Q28 (Loss)	97311B, 36620G (21)	36620B, 11591K (10)	Bonus/ no AWP
Q33 (Win)	36620B, 36620E (21)	61187D, 2140E (6)	Bonus/ AWP
Q48 (Loss)	32285C, 36620D (11)	96959B, 36620B (6)	Bonus/ no AWP
R16 2-5 (Win)	36620A, 36620B (36)	11986M, 96959A (3)	Bonus/ AWP
QF 2-1 (Loss)	36620A, 36620B (13)	2140F, 36620F (23)	Bonus/no AWP

Final record: 5-3-0
Quali Ranking: 8th

Takeaways

- **Q12**
    - We started the day good with a win, pretty easily getting the auton bonus and going on to not make any major mistakes
- **Q23**
    - This match was a little bit different as we were the only team to be able to score. Due to that fact we faced a lot of defence, but only scoring a few rings was enough to win
- **Q46**
    - This was another match where our alliance was the only one to score, together with our teammates, we secured the auton win point and the match as well, boosting our rankings a lot.
- **Q59**
    - Another good win, despite our battery coming loose and disconnecting mid match, we won with the help of our teammates.
- **Q77**
    - Another win, our teammates were fun to play with, against some decent teams, but with some good defence, we won the match.
- **Q93**
    - Another strong alliance, we were able to easily secure the auton bonus and win point, and go on to win the match.
- **R16**
    - Coming out of alliance selection as the 1st ranked team has many advantages, and this was one. Our first match was pretty easy and we used it as a warm up for our upcoming matches.
- **QF**
    - With the practice of the first match to finalize our strategy, we were confident coming into the next playoff match. This ironed out strategy and confidence lead us to win this match against strong opponents.