Engineering Notebook

75019E

Team Number

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Team Name

Coppell High School

School

09/15/2025	1/28/2026	1	of 1
Start Date	End Date	Book #	

V4.0 Date 3.27.25

VEX ROBOTICS

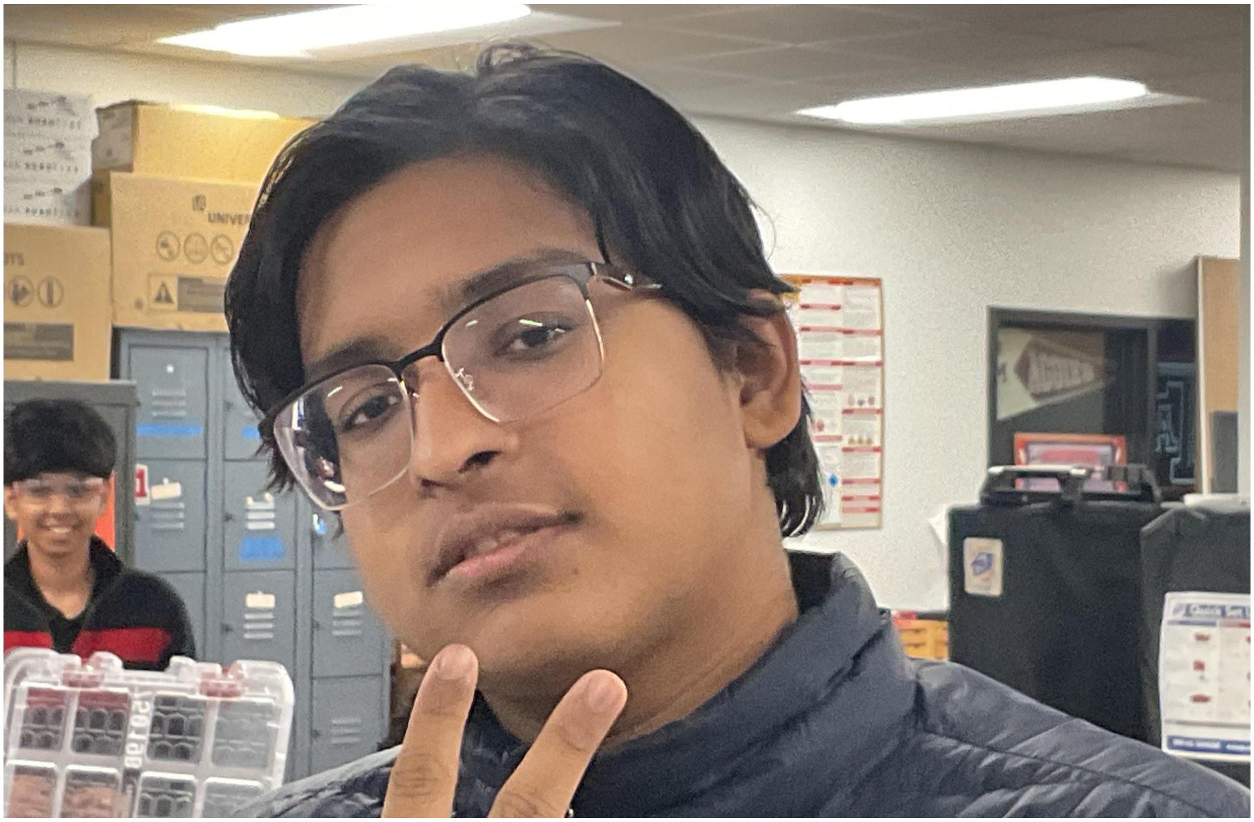
REC FOUNDATION

Table of Contents

Table of Contents

Section A

Introduction to all the team members



How the team started

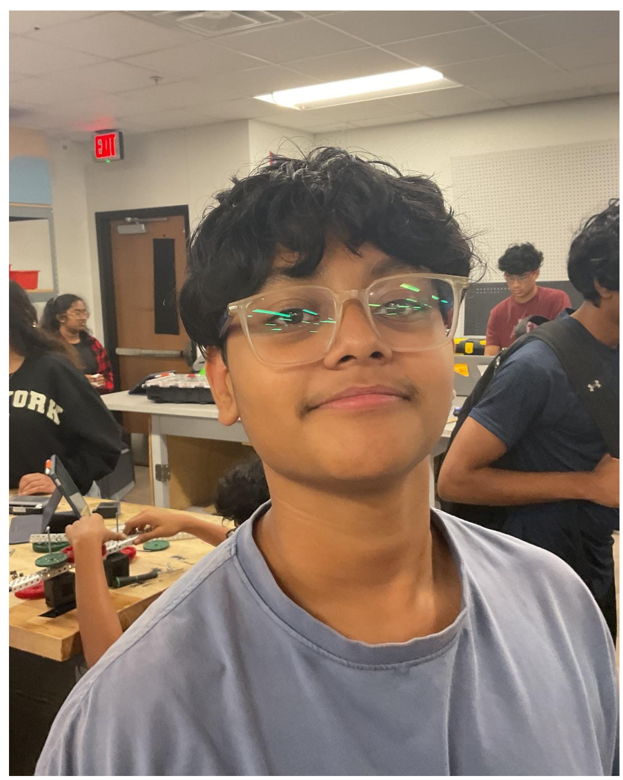
Our team captain, Arnav, started assembling a team for VEX, however he realized that all of the experienced people were committed to other teams and could not work in our team. So he had to turn to the new sophomores who had no experience in VEX. Most people in our team have barely any true experience in VEX robotics. This caused a lot of the team to rely on our team captain, Arnav. However Arnav was one of the most patient and loving people we know, because of this we overcame every obstacle and problem to create a hard working, focused, and creative team of engineers full of passion and energy. He worked hard to figure out the people that would suit better for the team; he never took any decision on his own but rather preferred to ask us and take a vote on what sounded good to him. For example, when he was selecting the people for our team, he consulted with all of the already inn members about they guy he was thinking to take in the team. If everyone agreed or there were majority votes, then the guy got into the team otherwise Arnav generally apologized the guy to whom he was talking to and explains him the situation. During the time in VEX, Arnav had some tough times wherein he just got to trust his teammates. He consulted with everybody about the guy he trusted the most and made him the team captain (Vedant) for temporary purposes and in the long run, he made him the team's vice captain.

Team Captain, Coder, Building Instructor - Arnav Gupta:

Arnav is our captain, Arnav is a highly experienced coder who has done AP computer science A as a sophomore. He also has experience with vex as he has done vex v5 last year and even went to state, he also used to teach vex IQ. Arnav's dream is to go to MIT and eventually start his own company.

Instagram manager, documenter, website builder - Vedant Bansal:

Vedant Banal is a ambitious person whose passion for engineering makes him constantly improve and innovate. He is deeply interested in robotics, Vedant has strong problem solving skills and is always willingness to help.

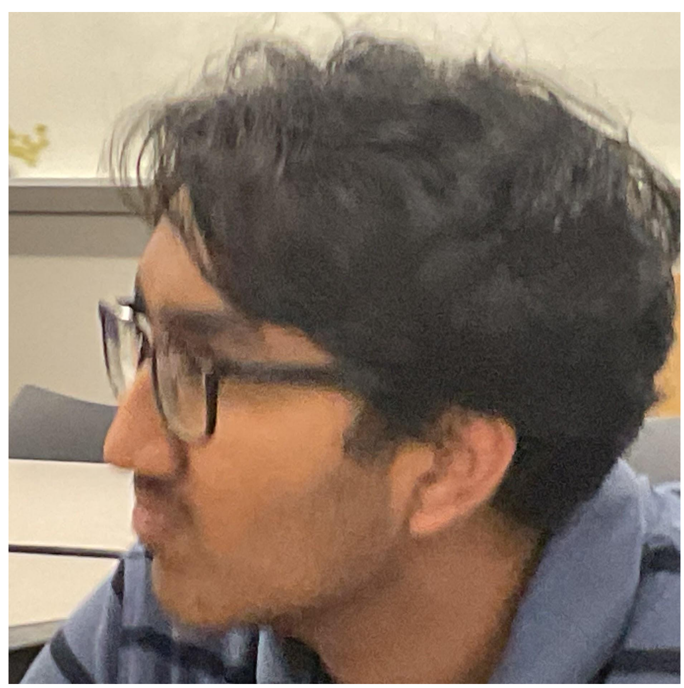


Lead Builder - Saharsh Ambati:

Saharsh is our lead builder, he is a extremely social person and is very easy to work with. He doesn't have any experience in vex but he has made many robots from kits that he bought. He has been intrigued by building and coding since he was a kid. He is a very coordinated person making him the perfect person to be the lead builder.

Lead Documenter - Sherwin Yella:

Sherwin is the leader of the documenters, he has taught his fellow documenters all about how to properly record and detail. He personally lead our documenters through the process of creating this book. Despite being a leader to us documenters, he had very little experience in VEX however he is extremely talented and invested in robotics and coding. Sherwin is also our merchandising and branding lead, meaning he has helped us create our Instagram account and merch.



Documenter, Team Assistant - Atharv Singh:
Atharv is our documenter, lead by Sherwin. Atharv dreams for MIT. Right now, he documents and follows Sherwins lead. He has prior experience in robotics through vex IQ. He is extremely talented and he knows it. He has been doing robotics and engineering since elementary school and it has always been his passion.

Documenter Co-Leader, Assistant - Adam Cler:
Adam is a documenter for our team. He also assists in various tasks, similar to Atharv. Being a Co-Leader of documenting, Adam provides much assistance and advice to Sherwin (Documenting Lead). Adam had little experience in robotics or VEX before this. Engineering and Robotics has always been Adam's passion, even from a young age. He has very little experience, however he was still graciously accepted into Arnav's team. Adam is one of the hardest working people in our team and is always willing to help even if it is something outside his expertise.

Builder, Driver -
Noah Law:

Noah is our driver and builder. He just got his licence and loves to drive. When he isn’t driving he is helping everybody build. He loves building things like legos but he has never done robotics before but he is ready to learn.

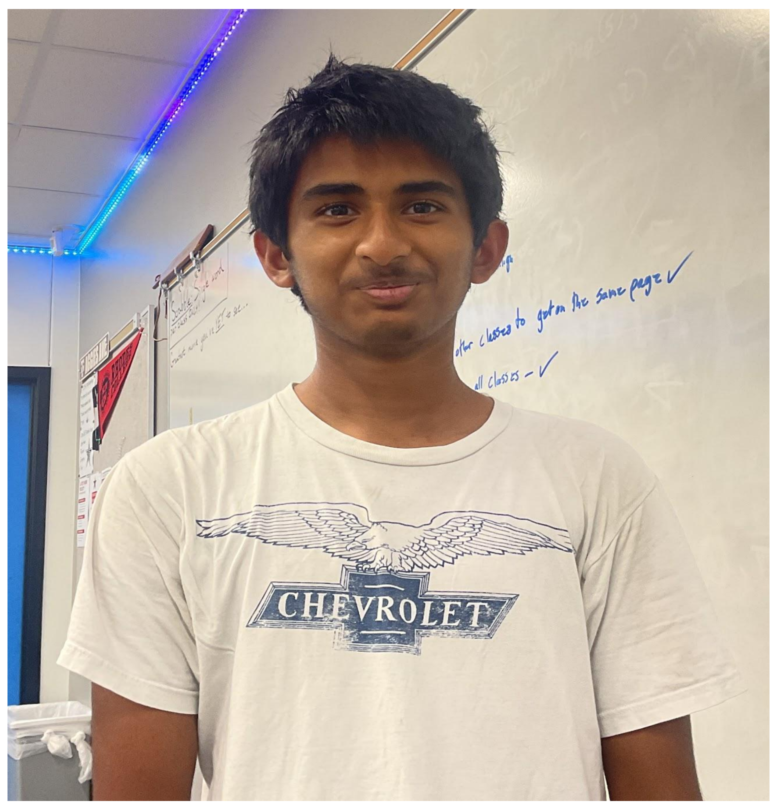
Builder, Designer -
Amogh Jha:

Amogh is one of our builders. He helps design and build our robot. Amogh is very adaptable and has a deep understanding of robotics as he has been interested in building since he was a little kid through legos and taking apart rc cars. While this is his first time in VEX, he is ready to learn and put in full effort.

Programmer - Shaurya Arora:
Shaurya is an extremely experienced programmer. Shaurya is a junior, however he has never done vex before. Despite his lack of experience in VEX he has done many coding classes and can code in 3 languages. Shaurya always brings has a positive attitude and keeps everyone on the team focused.

Builder, Kaarthik Tammineni:

Kaarthik is our team's builder. His duties include finding parts, building the robot, and helping out wherever he can on the team. He has never done robotics before but engineering has always been his interest. He is also very interested in band.



Section B

Push Back Explained

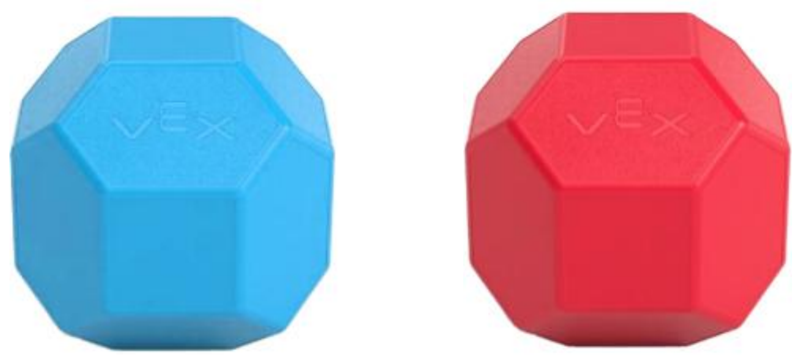
The Game’s Rules (Push Back)

The Objective: To Score The Highest Points

Base rules:
- Played on a 12x12 ft field
- One blue team and one red team
- 2 robots per team

The Scoring Element:
- The scoring element is a 18 sided block with a length of 3 ¼ inches
- There are a total of 88 blocks (44 for each team)

The Blocks:
Used for scoring



Where the Blocks are obtained:
- Blocks can be obtained from one, the field, which starts off with 36 blocks (18 blocks per team)
- Blacks can also be obtained from one of the 4 loaders in the corner, which begin with 6 blocks each (3 blocks per team), also loaded throughout the match.

Scoring Locations:
- There are 4 scoring locations
- 2 long goals on each side of the field
- 2 smaller center goals, one lower, one higher, both perpendicular to each other

How the match begins:
- All 4 robots start with a 1 block reload
- Matches begin with a 15 second autonomous period, with no manual input, and must remain full on their side of the field.
- Teams may be rewarded an autonomous point by doing certain tasks during the autonomous period.
- The 1:45 period begins once the winner of the autonomous period is decided.
- No robot block possession limit

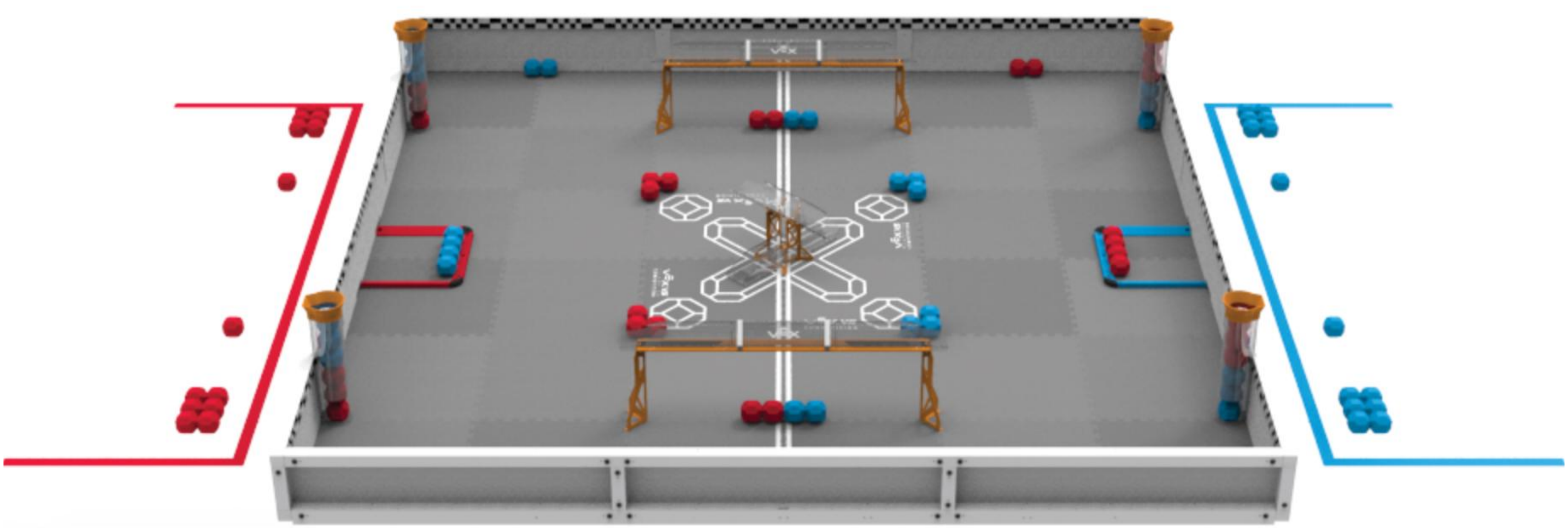
Scoring Points Explained:

- Each block scored is worth 3 points
- Long goals hold 15 blocks while center goals hold 7
- When a goal is full, putting a block in it pushes the block on the other side out.
- The team with the most blocks in the 4 block center of a long goal will get an Additional control bonus of 10 points.
- An 8 point control bonus will be given to the team with the most block in the upper center goal, and a 6 point control bonus for having most of the blocks in the lower center goal
- At the end of the match teams can get additional points by parking their robots in the parking zone.
- 1 robot parked = 6 points

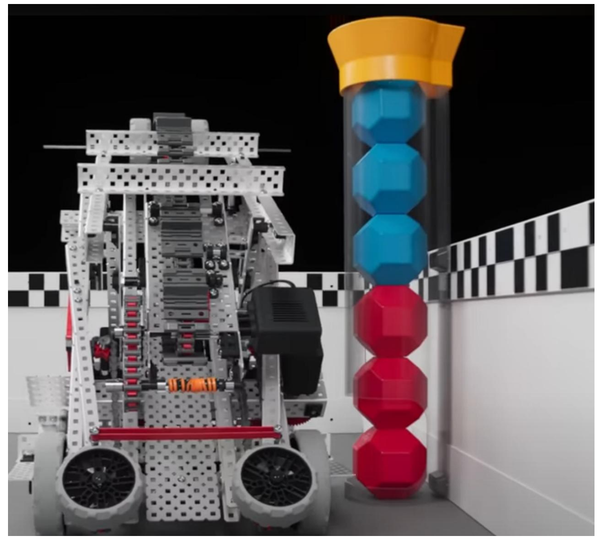
In Summary:

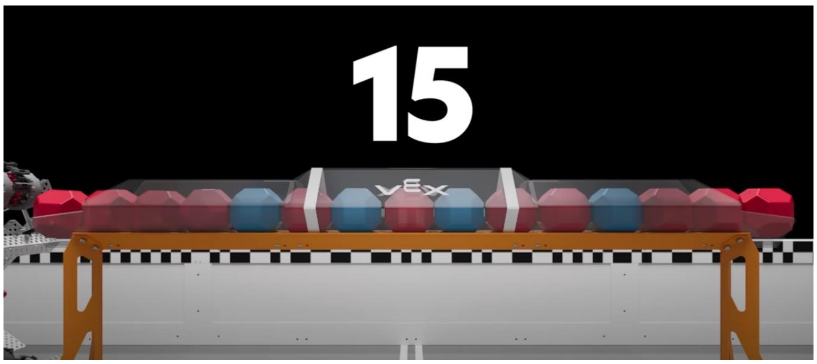
- Successfully completing the Autonomous Section results in a 10 point Autonomous Bonus
- Each block placed in a goal is 3 points
- Each controlled zone in a long goal is 10 points
- Controlled Center Goal - Upper is 8 points
- Controlled Center Goal - Lower is 6 points
- 1 parked alliance bot is 8 points
- 2 parked alliance bots is 30 points

The Playing Field:



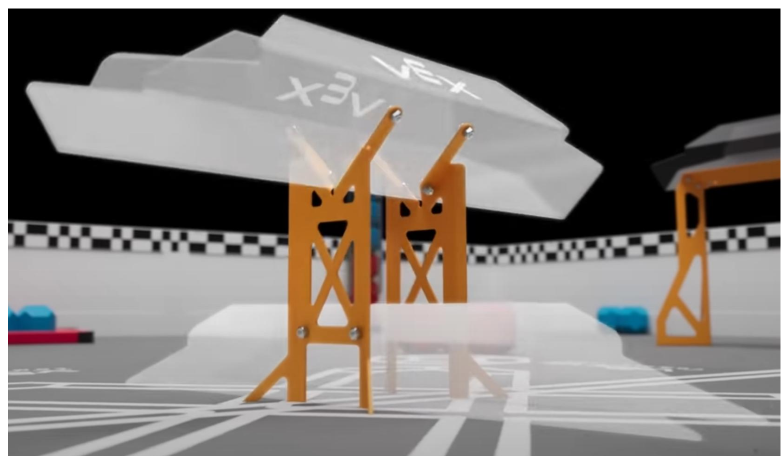
The Ball towers - ball dispense through the bottom, one in each corner





The Long Goals - 2 long goals that can be used to score points

The Center Goals - 2 center goals that can be used to score points.



The Parking Zone - Can be used to park 1 or 2 of your robots to get additional points at the end of the game.

Section C

Explanation of our Brainstorming

Brainstorming Designs

This section will show you the brainstorming of designs process, in which we show you the designs we went through, what we thought were the benefits, what we thought were the negatives, and most importantly why we picked the design we ended up with.

There will also be a addition of pictures, circling specific parts, and sketches to make out descriptions more easier to understand.

The 3 designs we will be going over:

1. **S design**

2. **C design**

3. **Track design**

First Design: The S design
Core summary

The S bot has 3 main components.

1. The front/bottom is the intake

2. The mid section which stores the cubes

3. The top which is the scoring mechanism

S design - The Intake

- The robot approaches the blocks and uses a intake mechanism that uses a wide mouth and rollers angled outwards to get blocks while moving. This allows for the robot to pick up blocks fast without having the need to slow down or stop.

- When the block reaches the intake it takes it into a short channel which then leads it into the staging area

- This is also where the first turn of the S shape happens where it turns into the staging area, unlike most designs where it leads straight to the scoring part.

- This intake design is pretty good as it uses angles pieces to align blocks to be properly taken into the bot and utilizes rotating rubber bands to grip the blocks and take them into the block without the blocks getting stuck.

S design - The Staging phase

The staging phase is the first place where the S design has its benefits

- The S design is one of the bots with the highest amount of block storage

- There is always a block ready to use for the scoring while the previous mechanism collects the cubes ensuring you don't have to move forward the other blocks in order to score another block which is not a benefit on many other designs.

- This section also has the optical sensor and encoder which can distinguish between the 2 different colored block and can tell the robot and driver when the staging storage is full, this helps ready up the blocks to score and to be able to store blocks whilst activating the scoring mechanism.

S design - The Scoring phase

- When the driver triggers the score input on the controller, the input is sent to the brain which activates the scoring mechanism

- The scoring mechanism works using a lift to raise the block to the correct height (using pneumatic pistons and gears), and align it with the goal.

- This happens once the scoring mechanism is done.

- After scoring, the mechanism resets, the the pneumatic pistons and gears reset to their default position ready to be used again to score

- In summary: Block come from intake, stage sends it to lift, the lift scores it in the scoring area.

S design - How it works in summary

- The S design is basically divided into 3 sections, the intake, the staging zone, the scoring mechanism. These 3 area connect resembling an S shape, giving it it's name.

- This allows the robot to do multiple functions while not interfering with each other.

- This design is ranked the highest in one video by the "Vex analyst" due to its high blocks per minute count and that it scores very efficiently while being manageable to control.

S design - Its Benefits in detail

- Because the staging and scoring mechanism is split the robot does not have to ever have to wait idle to either pick up blocks or score blocks and can do both at the same time while staging said blocks for scoring, this allows for significantly higher block scoring count than other designs.

- You are not required to score and can hold your position if the other team is using a goal you want to use, you have the option to wait and pick up more blocks because your intake and staging is separate from the scoring part.

- Is better than other designs because it has a much higher storage capacity and does not run out of blocks too fast.

- Allows the driver to have way more options over the robot and what the driver can do by allowing to do other actions without interfering in one another.

S design - Its Flaws in detail

- More mechanically complex; one of the most complex robots, intake rollers, staging belt, gates, a lot of extra mechanisms. Means that more building time, more maintenance time, and higher chances for mechanical issues.

- Very heavy robot; means that robot has very high bulk which adds inertia making it slower, less reactive, and reducing stability.

- The scoring mechanism being separate from the staging makes it if the scoring mechanism can't keep up with the staging, blocks start building up and the driver can't go through them fast enough.

- If the driver mis-manages decisions they can fail to score properly or efficiently at times.

- The turns in the S shape of the robot has a chance of blocks getting stuck and slowing down the robot.

S design - What we decided

- Our team came to the conclusion to not pick this design

- This is because it would simply take way too long to build with our highly constricted build times.

- The materials needed to build this we simply lacked because the school cannot provide the robotics club enough money to be able to buy all teams this much materials.

- We lacked the experience to be able to make this in reasonable time as for all the builders it was a first time experience.

Second Design: The C design
Core summary

The C bot has 3 main components.

1. Drivetrain
2. Intake
3. Scoring Mechanism

C design - The Drivetrain

- Strong reliable Drivetrain that favors pushing power and stability over speed.

- The frame is wide and low giving the robot stability

- Has good torque which ensures when it is scoring the robot does not lose traction

- More consistent, and stable, which are highly valued in the autonomous because it will be more predictable.

C design - The Intake

- The intake mouth is wide and angled which makes sure it can reliably get blocks from all sorts of angles

- Starts the curve of the “C” path

- 4 rollers roll the blocks into the ramp into the lower section of the scoring mechanism

C design - The Scoring phase

- Is much simpler compared to the S design
- Has one continuous motion of block in one direction, making the design much simpler to make, basically more mechanically simple.
- Makes is so the driver can get the block they pick up very fast and ready to score
- Deposits the block in the scoring part
- Has a roller at the end that “spits” the block out at speed making sure if there's distance between the goal and the robot it may be able to jump over it, and makes sure if the goal is full to push out the other blocks.
- Because it is stable you can do this in one smooth motion and there is no need to stop.

C design - How it works in summary

- Very stable, consistent with movement, and strong frame which is very useful for the autonomous section and really helps the driver drive it during the even

- Utilizes one curve to direct the blocks in one direction to score making the design way more cheap, simple, and one way of motion.

- Is good for speed because it is one smooth motion rather than having to wait for the blocks to be processed it immediately.

C design - Its Benefits in detail

- Stability because of low center of gravity, makes movement way more consistent ensuring more predictable movement.

- Has strong drive and can push goals stronger

- Has less moving parts and more mechanically simple making it good because it can be made more easily with our constricted time, will be cheaper to make, and will be more easier to maintain for the competitions.

- One continuous motion with the curved lift allowing one smooth motion and faster time for the blocks to get to the scoring mechanism and making it so the robot doesn't have to wait for the blocks to get to the scoring mechanism for too long.

- The wheel at the end allows for the fast shooting of blocks to the goals

C design - Its Flaws in detail

- Limited storage capacity, unlike other designs it can’t store and process multiple blocks at the same time so no matter how the driver strategizes they can only pick 1 block up at time or score 1 block at a time

- Main negative is that it may lose to other bot designs simply because it cannot multi task and process and goal blocks at the same time.

- The entire arm has to move to score different goals which is a very slow process and in turn makes the scoring process even slower than it already is.

- Although more mechanically simple than the S “design” it is still very complex and has a way higher margin of error, making it less appealing to use as a design for the robot.

C design - What we decided

- Our team came to the conclusion to not pick this design

- This is because it still complex, though less than the S design, still is difficult to do in our highly constricted build times.

- The materials needed to build were way more possible but still pretty expensive

- And the biggest reason of all, it did not a reasonable amount of rewards for its flaws, it's too complex, too much margin for error, and worst of all it was equal or worse than other designs even though it used one of the most complex and expensive designs.

Third Design: The Track design
Core summary

The Track bot has 3 main components.

1. DriveTrain

2. Intake

3. Track

Track design - The DriveTrain

- The drivetrain uses 6 blue motors in total which gives the drive train the perfect amount of torque and speed necessary that we deemed for the competition

- It utilizes 2 omni wheels on both sides of the drivetrain and one friction wheel on each side to keep traction.

- It gives the robot a much higher torque, speed, consistency, and traction compare to other robot designs.

Track design - The Intake

- It is inspired from the hero bot but we had plans originally as well to modify it for the blocks to not get stuck in the intake

- It essentially uses sprockets, gears, and a motor to grip onto the block and suck it up in the intake and while the block went in it lifts itself up, the intake is one separate part of the robot that can move independently.

- Angled pieces of metal would be used to make sure the blocks don't get stuck in the intake

- Mechanically way more simple and cheap than other designs

- Its designs makes sure blocks can not fall out the other even if the robot is off by acting as a one way door

Track design - The Track

- The track is a 45 degree ramp that as the name suggests utilizes track, sprockets, and gears to move the blocks up the track into the exit point

- Track is split into 2, so there is a little gap in the middle to store one block

- Utilizes a net to let blocks across the track smoothly

- Utilizes pneumatics at the end to aim the block for the 2 different types of goals

- Overall incredibly simple design and I mean very simple

- Incredibly cheap, very easy to make, very easy to maintain

Track design - How it works in summary

- Is a very simple design that’s main focus is the drivetrain

- Incredibly simple track, intake, more complicated drivetrain but it is absolutely worth it and not more expensive or harder to make than other drivetrain designs.

- Center of mass is in the lower middle part of the robot making sure it wont go off balance

- Cheaper design and easy to maintain

Track design - Its Benefits in detail

- It is simple designed
- Easy to make, and maintain
- Utilizes less materials making it cheaper
- More simpler for the driver to plan and use in actual competition
- We believed it to be more efficient than other designs

Track design - Its Flaws in detail

- Does not allow for high storage of blocks and is constricted to have to move all blocks to score or pick up new blocks which can be very challenging in the competition.

- The track is too simple and will not be very consistent leading to it getting stuck at times with its default design.

- Is not great with speed or accuracy for scoring

Track design - What we decided

- Our team came to the conclusion to pick this design
- This is because this was the only design that met with our strict time constraint and a reasonably good design
- All of our team members agreed that this design would be able to actually do this on time and be able to maintain it easily

Conclusion

- We picked Track design
- And considered all of our options very carefully thinking about all the possibilities
- And Track design met most of the criteria's while being a decently good robot

Section D

Team Meetings

Our First Meeting:

Goal: Start Sorting inventory and Officially Meet Members
Accomplished:

- Most members met officially. Most team members were missing, with only the sophomores present. We discussed roles and a general plan for future meetings.
    - Future meetings: We decided that we were going to start sorting inventory and start documenting. In later meetings we would do an official inventory and start building practice/unofficial drivetrains.
- In this meeting we checked our kit and all the parts we had available to us. This was an unofficial inventory to check what parts we already had, and add a little organization to the our kit which looked like a tornado hit it. During this unofficial inventory we found many pats that were functional but even more that were junk.

Pictured: Saharsh Ambati organizing, here he holds a thoroughly bent L channel

First Meeting (cont.)

Observations:

- Many pieces were bent to various extents. Some were repairable, some slightly scuffed, while some were thoroughly beyond saving.
- We found multiple items that were trash, or possibly items used by the last team. These items were not VEX items. Some examples of the items we found:
    - A small pipe, possibly pvc with a rope strung through it so that it made a useless bow.
    - An L channel that was bent open, this particular item was the one held by Saharsh in the photo last page.
    - Multiple small Lego builds. They were all some small wheel builds that were no more than 10 bricks each. Why they were there we have no idea.

- Of the functional pieces we had, few were pieces we were sure to use. However among the pieces we knew we were going to use, there were many small screws, nuts, and axles.

Our Second Meeting:

Goal: Find parts and start building drivetrain models. Our enemy is parts.

Accomplished:

- We attempted to make a drivetrain. However we lacked the parts to make an official drivetrain for our robot. We needed to work on wheels for our drivetrain before we build a frame, and definitely before we wired up the motors.
- We managed to build about 3-4 wheels with gears attached before the meeting was over, however they eventually were scrapped as they would not work for our chosen design. This is because the screws we used were not flush enough with the gears, by the limits of our current design, the screws would hit the frame and prevent movement.

- As we did this we had to search through our kit. By doing this we found even more junk pieces.
    - Multiple pieces scratched beyond use.
    - Axles were bent very slightly so that it was hard to tell by sight, but they were exceptionally hard to push through a hole.

Our Second Meeting (cont.)

Observations:

- We still lack many parts necessary for our robot. In later meetings we were only able to build half-drive trains due to our lack of materials. These practice drivetrains were integral to our team understanding the strengths and weaknesses of our drivetrain design, as well as understanding how the drivetrain would work, its limitations, and leniencies.
- We noticed that our screws were unsorted, meaning we had no way to efficiently tell what size screw we were holding. This effectively tripled the time it took to attach wheel to a gear.

Next Steps:
Continue gathering parts and building smaller drivetrains for practice.

Our Third Meeting:

Goal: Build a model half drivetrain to understand mechanics. This includes creating the frame as well as attaching motors and wiring said motors to the brain.

Accomplished:

- We gathered the parts we needed for the build which included nylock nuts, C-channels, axels, omni-wheels, and gears. With this build we were experimenting with gear systems and making sure we knew how the to wire the brain right.
- Adam created attached gears to wheels so that they could all spin. Arnav built a frame to hold it all together. This took a few tries as the wheels were too big to fit into the frame the first time. After we assembled the system Saharsh wired up the motors to the brain and the brain to a controller.

Our Third Meeting (cont.)

Observations:

- We are low on pieces, as our parts order has not come through yet. This prevents us from working on an official drivetrain for now.
- This model drivetrain, while flawed, could be scaled up and tweaked a lot to create our official drivetrain.
- Things we would need to change:
    - Obviously make it a whole drivetrain rather than half
    - Add a small wheel in the back for turning
    - Add more wheels when it scales up
    - We will probably have a mixture of friction and omni-wheels

Omni-wheels on the left, friction wheels on the right.

Next Ste

Next meeting we will start brainstorming ideas for merchandising. This is a crucial step if we make it to alliances. The documenters will sit down and put together some ideas for merchandising. We will also have to do a full, official kit inventory.

Our Fourth Meeting:

Goal: Marketing and inventory all items.
Accomplished:

- We successfully inventoried all items in our kit. Doing the inventory of our kit allows us to work on the robot at home during the weekends. It also lets Mr. Brown send in the parts order. Below we have a sample of our work that we put into a sheets document.

VEX V5 Competition Super Kit Parts List			
Parts	Quantity	Part Number	Price
Electronics			
			All prices are in sets unless sold individually
(1) V5 Robot Brain	1		375
(1) V5 Controller	1		133
(1) V5 Robot Radio	2		47
(1) V5 Robot Battery Li-Ion 11 00mAh	1		75
(1) V5 Robot Battery Cable	1		35
(1) V5 Robot Battery Charger	1		13
(8) V5 Smart Motor	7		32
(2) 36:1 Smart Motor Cartridge	0		13
(1) Vision Sensor	0		90
(4) Bumper Switch v2	0		15
(3) 300mm Smart Cables	3		12
(3) 600mm Smart Cable	2		12

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	A	B	C	D
1	VEX V5 Competition Super Kit Parts List			
2	Parts	Quantity	Part Number	Price
63				4
64	Structure			
65				
66	(2) 1x2x1x25 Aluminum C-Channels	1		35
67	(24) 1x2x1x35 Aluminum C-Channels	2		43
68	(12) 1x3x1x35 Aluminum C-Channels	2		43
69	(6) 5x25 Aluminum Plates	0		30
70	(4) 2x2x25 Aluminum Angles	1		43
71	(4) 1x1x35 Aluminum Angles	0		29
72	(4) 90-Degree Gussets	0		10
73	(175) #8-32 x 1/4" Locking Star Drive Screws	0		6
74	(125) #8-32 x 1/2" Locking Star Drive Screws	0		8
75	(250) #8-32 x 3/8" Star Drive Screws	0		8
76	(225) #8-32 x 1/2" Star Drive Screws	0		8
77	(100) #8-32 x 7/8" Star Drive Screws	0		8
78	(75) #8-32 x 1.000" Star Drive Screws	0		8
79	(50) #8-32 x 1.250" Star Drive Screws	0		8
80	(50) #8-32 x 1.500" Star Drive Screws	0		8
81	(25) #8-32 x 1.750" Star Drive Screws	0		8
82	(10) #8-32 x 2.000" Star Drive Screws	0		8
83	(20) 1-Post Hex Nut Retainers w/ Bearing Flat	0		6

VEX V5 Competition Super Kit Parts List			
Parts	Quantity	Part Number	Price
Motion			
(4) 4" Omni-Directional Wheel	8		30
(4) 4" traction Wheels	2		15
(8) 12T Metal Pinion	2		24
(8) 36T High Strength Gears	3		19
(8) 60T High Strength Gears	0		19
(8) 84T High Strength Gears	0		19
(32) High Strength Square Gear Inserts	0		6
(32) Free Spinning Gear Inserts	0		
(4) 6T High Strength Sprockets	0		16
(6) 12T High Strength Sprockets	0		16
(6) 18T High Strength Sprockets	1		16
(2) 24T High Strength Sprockets	0		16
(2) 30T High Strength Sprockets	0		16
(700) High Strength Chain Links	43		17
(100) Chain Attachment Links	175		17
(50) Tank Tread Traction Links	74		35
(60) Conveyor-belt Base Links	115		30

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	A	B	C	D
1	VEX V5 Competition Super Kit Parts List			
2	Parts	Quantity	Part Number	Price
86	(700) #8-32 Nylock Nuts	200		5
87	(100) #8-32 Hex Nuts	15		4
88	(12) Pillow Block Bearings	0		6
89	(40) Bearing Flats	5		6
90	(8) Drive Shaft Bar Locks	2		8
91	(20) 1/2" Standoffs	1		4
92	(30) 3/4" Standoffs	5		5
93	(20) 1" Standoffs	8		5
94	(40) 2" Standoffs	3		10
95	(4) 3" Standoffs	3		9
96	500 inch standoff			
97	Tools & Accessories			
98				
99	(20) #64 Rubber Bands	2		6
100	(600) 4" Zip Ties	0		6
101	(50) 11" Zip Ties	0		9
102	(1) 12" X 15" Anti Slip Mat (Thick)	0		3
103	(4) T15 Star Screwdrivers	6		19
104	(2) T15 Star Keys	2		10
105	(2) T8 Star Keys	3		10
106	(6) Open End Wrenches	2		35
107				
108				

Fourth Meeting (cont.)

Accomplished (cont.)

- The team documenters (Sherwin, Adam, and Atharv) left the lab and went into Mr. Garner's room to start brainstorming ideas for merchandising. Here we have our logo that our Team Captain Arnav came up with:

- We came up with some ideas including:
  - Stickers that other teams or potential allies could take from us. They would sport our logo, and that's it due to their size.
    - pros: small, cheap, easy to give away/sell.
    - cons: not very convincing, not very durable.
  - Shirts that would have our logo. We could design these on Custom Ink or some other apparel-designing websites.
    - pros: durable, convincing, official looking
    - cons: not cheap anymore, what do we do with the excess?

Fourth Meeting (cont.)

Accomplished (cont.)

- Hoodies, similar to the shirt but more comfortable and more expensive. This is will be fairly very costly.
  - pros: looks very professional and official, very comfortable (depends on material really),
  - cons: VERY EXPENSIVE, might not sell/give out well.
- Pins with our logo would look cool and are more durable than stickers. Not sure how to make them though.
  - pros: durable, cool, professional.
  - cons: not sure how we would go about making them, could be very expensive.
- Fake tattoos, this may not be the best idea but it was Adam's first thought for some reason. Having a logo printed directly onto people's skin would be crazy marketing.
  - pros: not many pros other than its cool.
  - cons: it's just not a great idea, pretty expensive, probably won't sell well, not very professional.

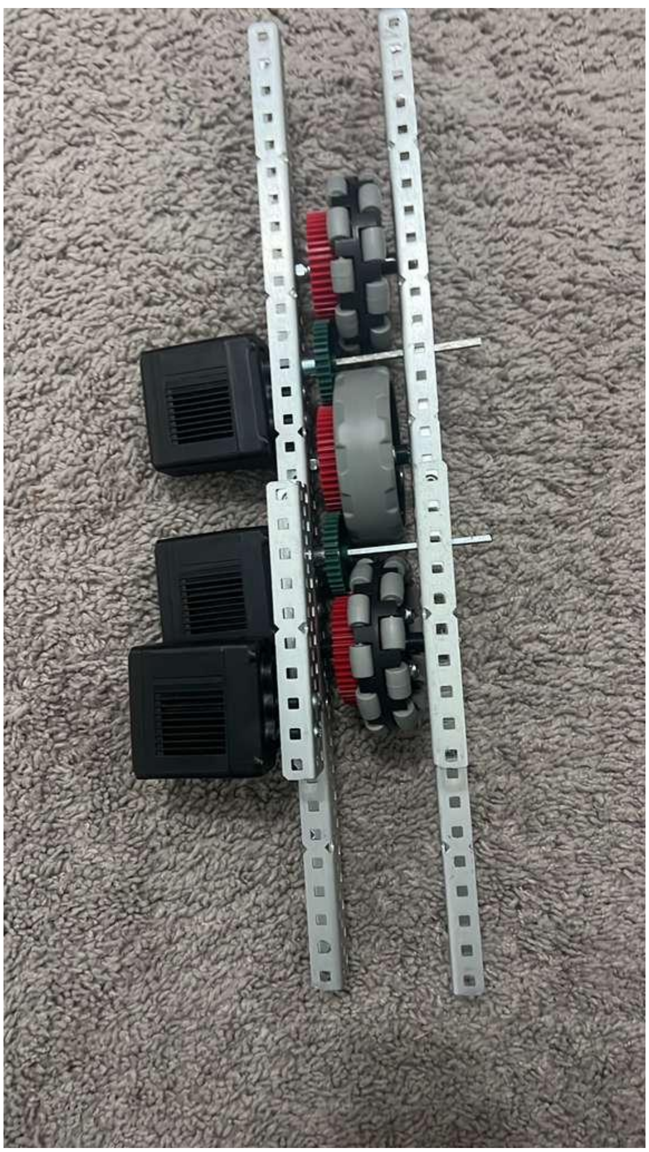
We ran out of things to write for meeting four so here is a photo of Arnav.

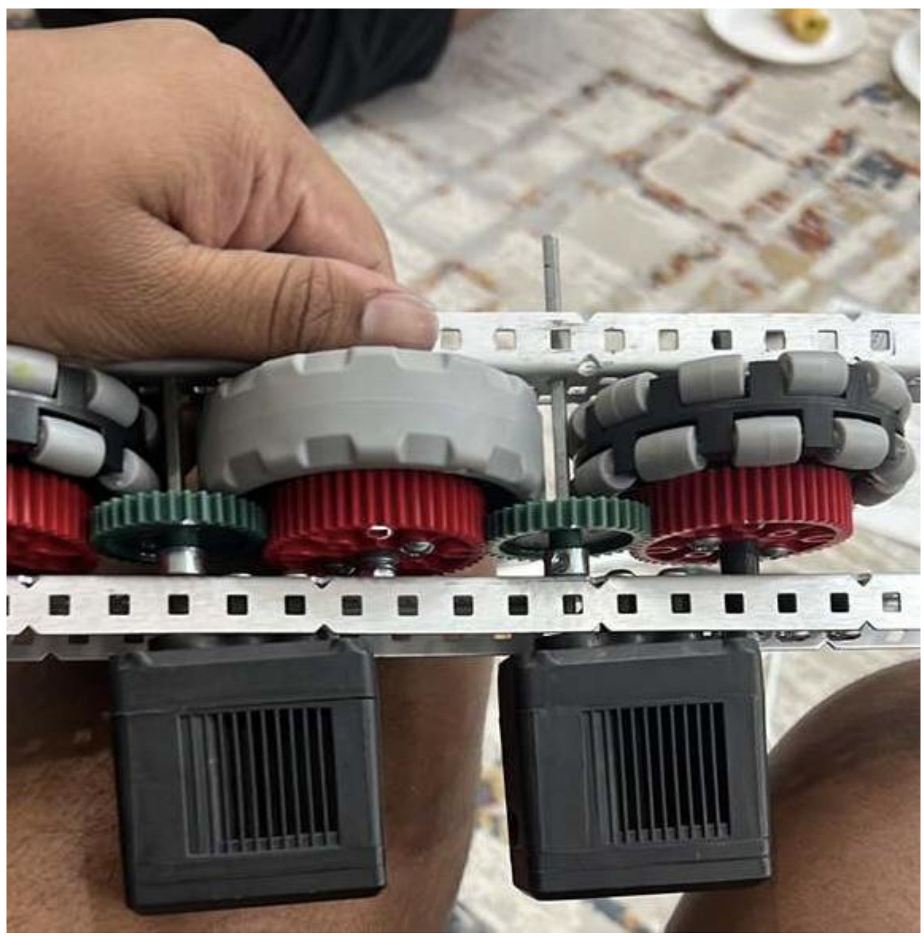
Our Fifth Meeting:

Goal: Create an experiment drivetrain that may act as an official model for our real drivetrain.

Accomplished:

- Below is the drivetrain we built this meeting. It is only a half drivetrain and it is flawed, but it is a very good option for our real drivetrain. We used C-Channels that are turned outwards, 2 omni-wheels and a friction wheel, 5 gears, and 3 motors to run.
- We chose to sandwich the friction wheel because we thought this would give us the most mobility and agility.
- The motors connect to the green gears, one motor to nothing.

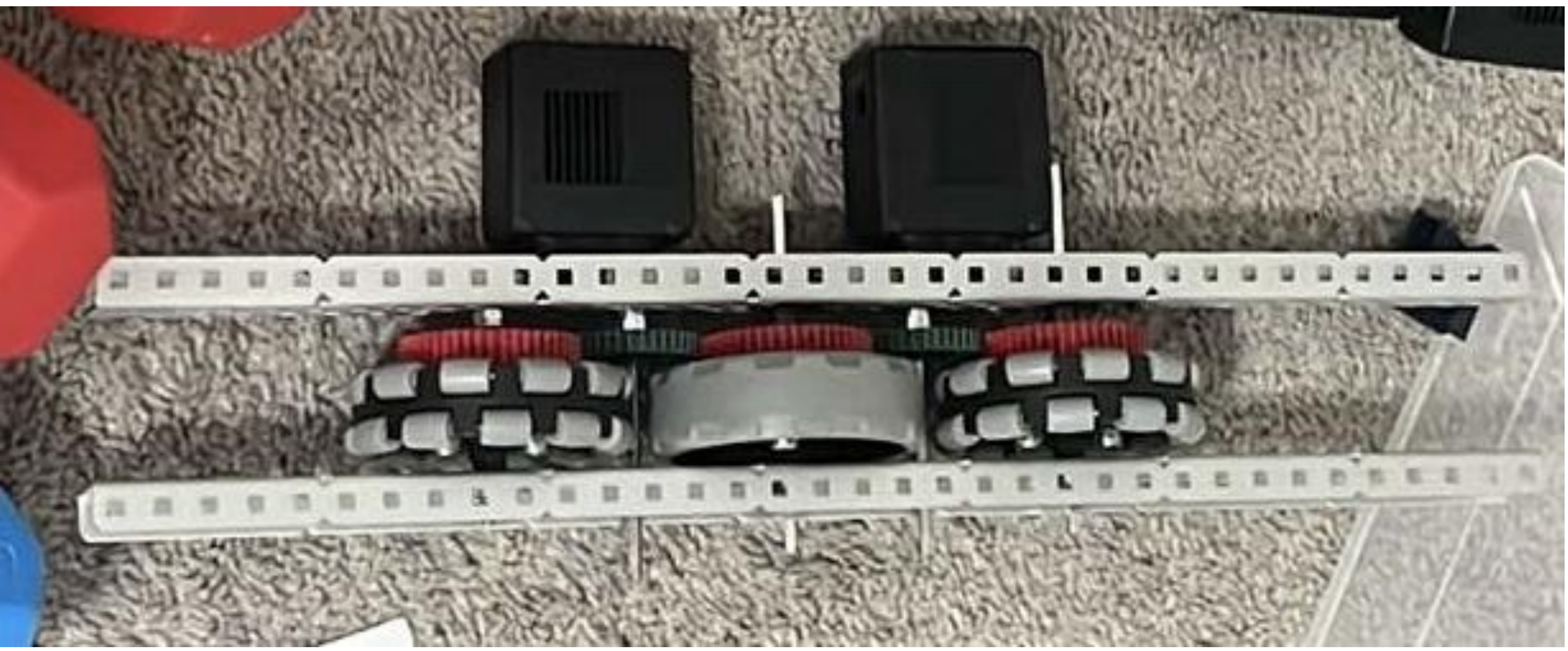




Fifth Meeting (cont.)

Observations:

- The outturned C-Channels will probably work however we will need to add a place to put the brain, preferably next to the motors, this means that the motors will be on the inside of the robot.
- We will need a small wheel at the back to turn the bot easily and quickly this will require another motor which is a annoying, but the mobility it gives the driver far outweighs the material cost.



Next Steps:

We will need to fully build the drivetrain. We will tweak the half we already have, but just a bit. Once we have a drivetrain we can start making the top half and intake.

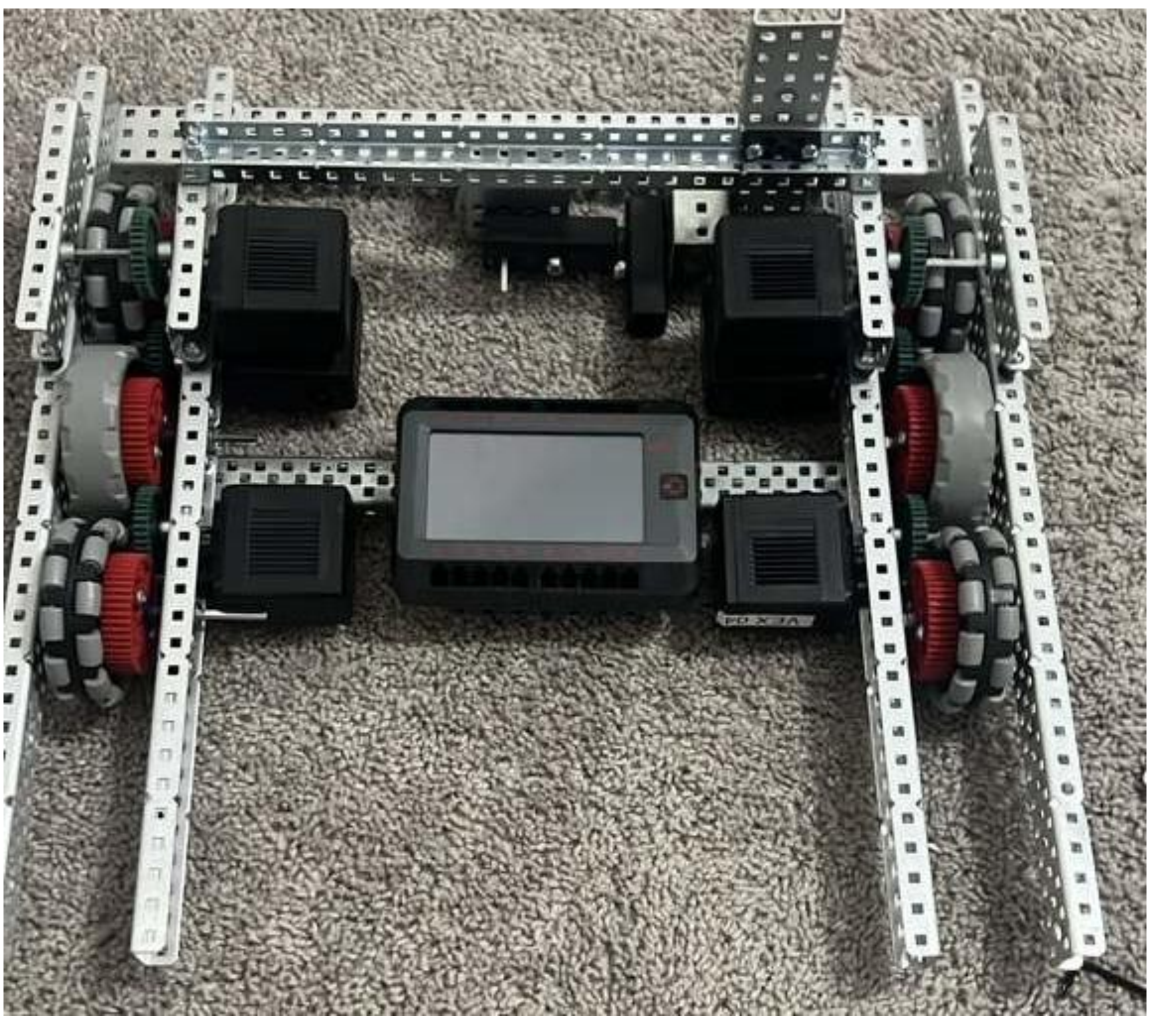
Our Sixth Meeting:

Goal: Build a finalized drivetrain so we can start working on intake and everything else.

Accomplished:

- DRIVETRAIN COMPLETE.
- We have a fully functional drivetrain that includes:
  - 4 omni-wheels
  - 2 friction wheels
  - A place for the brain to sit
  - Another motor with a small wheel for turning

For more info on the drivetrain, consult section E



Sixth Meeting (cont.)

Observations:

- Axles were not lining up. We put an axle in a hole in one C-channel, but due to either human error or a broken axle, they occasionally did not match up to the opposite hole which stopped the whole thing from working and put wear on the motor.
- Screws were unorganized and of random lengths. Our screws were unsorted which made it very tedious to get through the building process. It was better than before in previous meetings, when we didn't even have the right lengths at all.

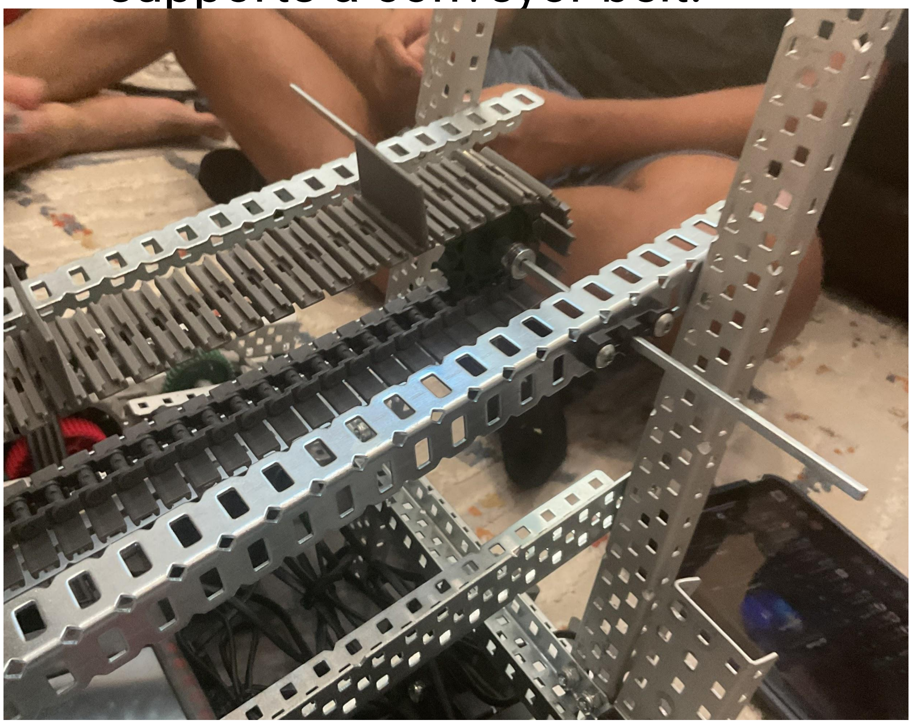
Through trade and negotiation with other teams, we gathered the necessary parts to build this drivetrain. We were gifted functional parts that we had but were broken, and other parts that we needed but didn't have at all.

Next Steps:
We will next make the intake using a very long meeting. We already had some ideas floating around, so it won't be too hard. The intake is the most necessary part of this build, so it will need to be perfected.

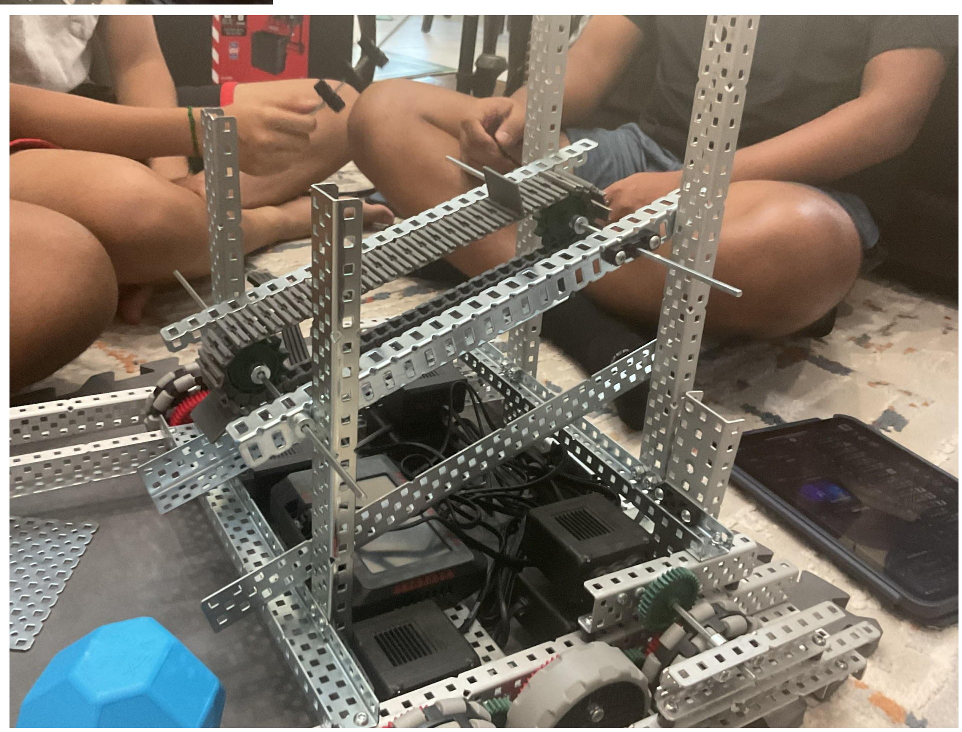
Our Seventh Meeting:

Goal: Build intake on top of drivetrain
Accomplished:

- Our design that we had originally settled on had a good intake, however through extra discussion and brainstorming we came up with this intake. It is built with a slanted metal frame that supports a conveyor belt.



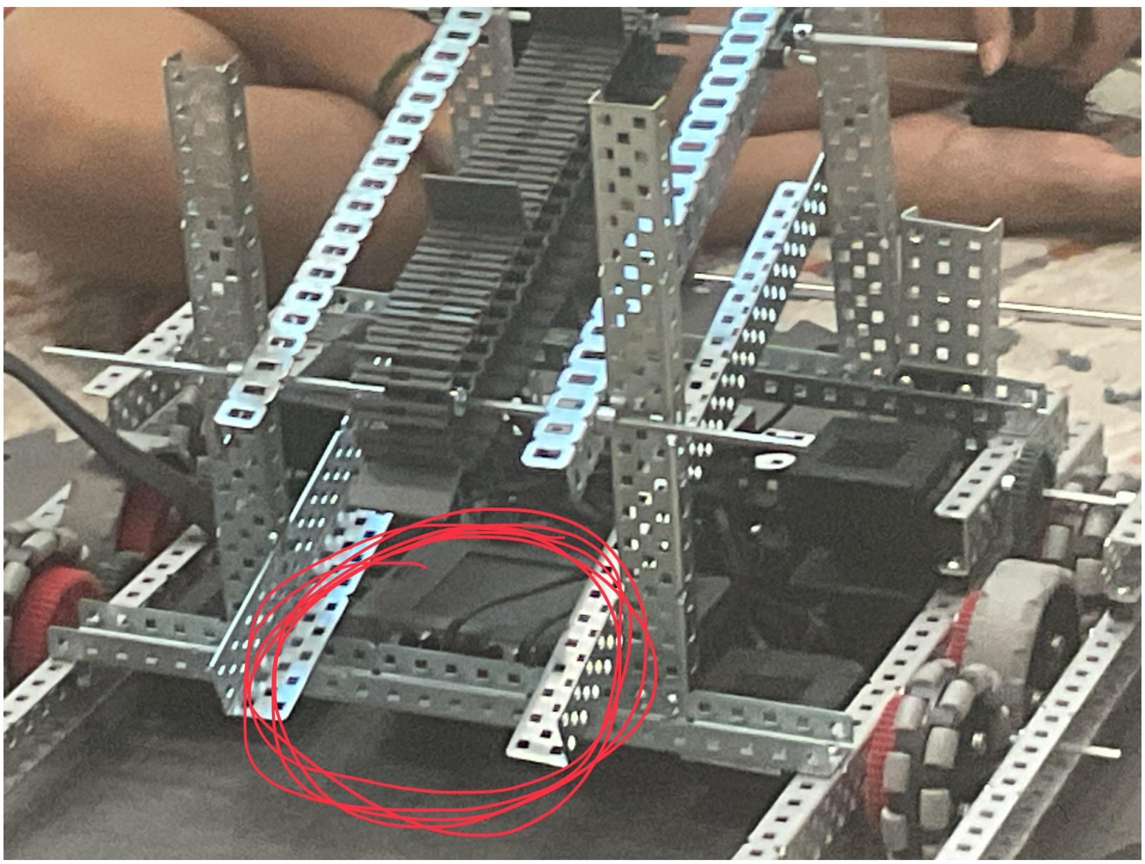
The photo on the left has a close up view of our conveyor belt. It has tabs to help pull up balls. The photo on the bottom shows our whole bot as it is now.



Our Seventh Meeting:

Observations:

- The intake was built and tested for the first time but to our dismay, a small support C-channel stopped the ball from being able to go into the intake. This bar is a little too high and thus disables our intake.
    - Because of this defect, we have to cut the walls of the C-channel, and bend them down.
- The back of the intake needs to have some kind of support, otherwise the ball will just fall into the machine.



<—The offending bar

Next Steps:

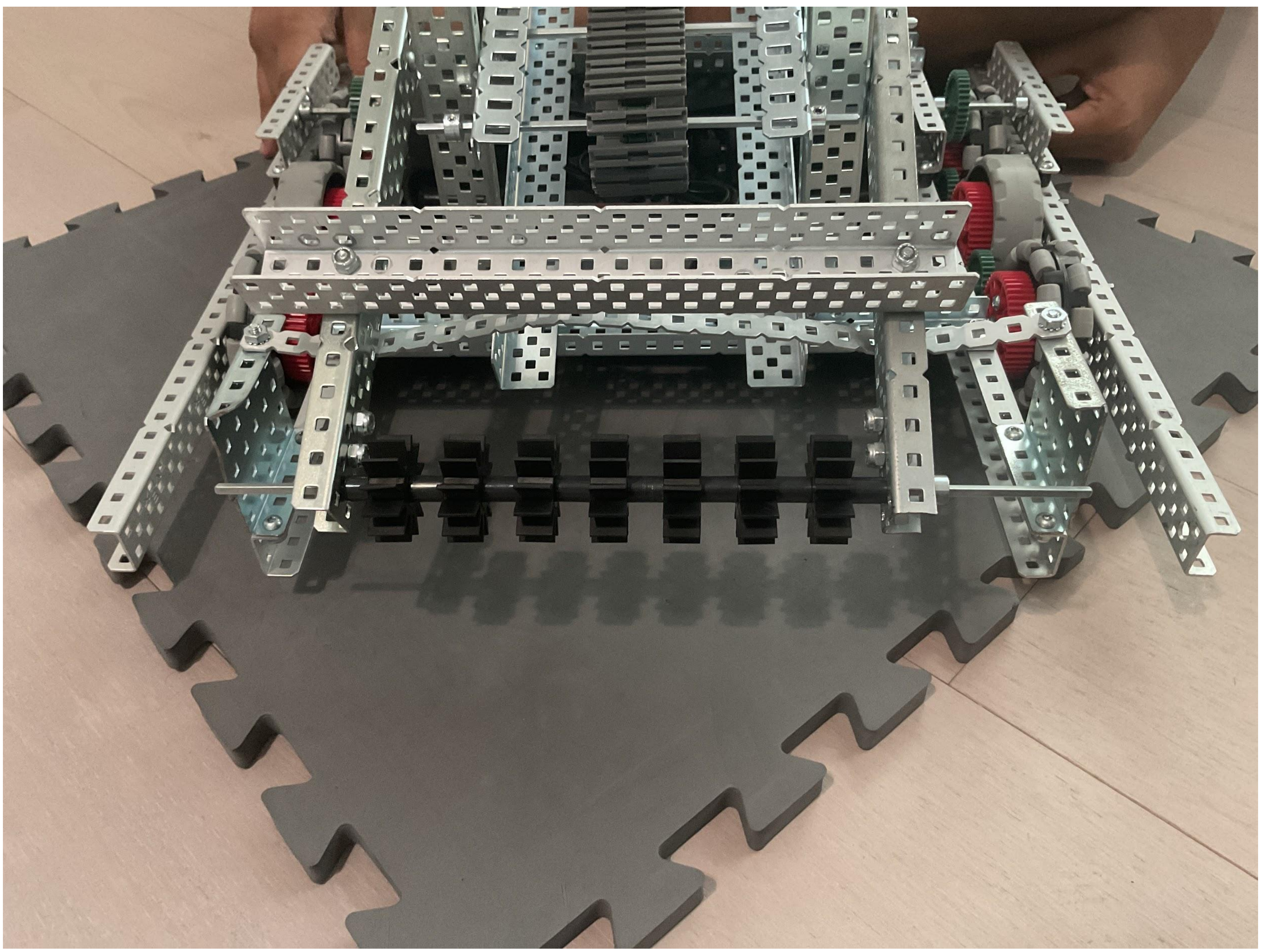
Fix the intake, test it. We might want to add an extension to add extra reach to our bot.

Our Eighth Meeting:

Goal: Create a functional intake extension.

Accomplished:

- We created an intake that can move up and down, and has flexible fans on the front to help pull the balls in. You can see it right there in the front, it has black spinning fans.
- We used a bent part to increase the height and capability of the intake. This is a temporary solution until we decide what to do with the bad C-channel in the intake. For now it requires a bit of force to intake a ball.



Our Eighth Meeting:

Observations:

- We will need to fix that bar eventually. Here are some options we have with pros and cons.
- **Bending the bar:**
    - **Pros**: pretty easy, not time consuming.
    - **Cons**: might not be totally effective, will weaken the bars support power.
- **Removing the entire middle of the bar:**
    - **Pros**: will work for sure, not as hard or time consuming as removing the whole bar.
    - **Cons**: will take away structural integrity, will be time consuming and annoying.
- **Removing the bar:**
    - **Pros**: has a good chance of working.
    - **Cons**: we will have to find a whole new piece to replace the bar. The act of removing it and finding a replacement piece will be very difficult and time consuming.

Next Steps:

Decide on a solution. Create an output for the robot. This will be the part that pushes balls into the goal.

Our Ninth Meeting:

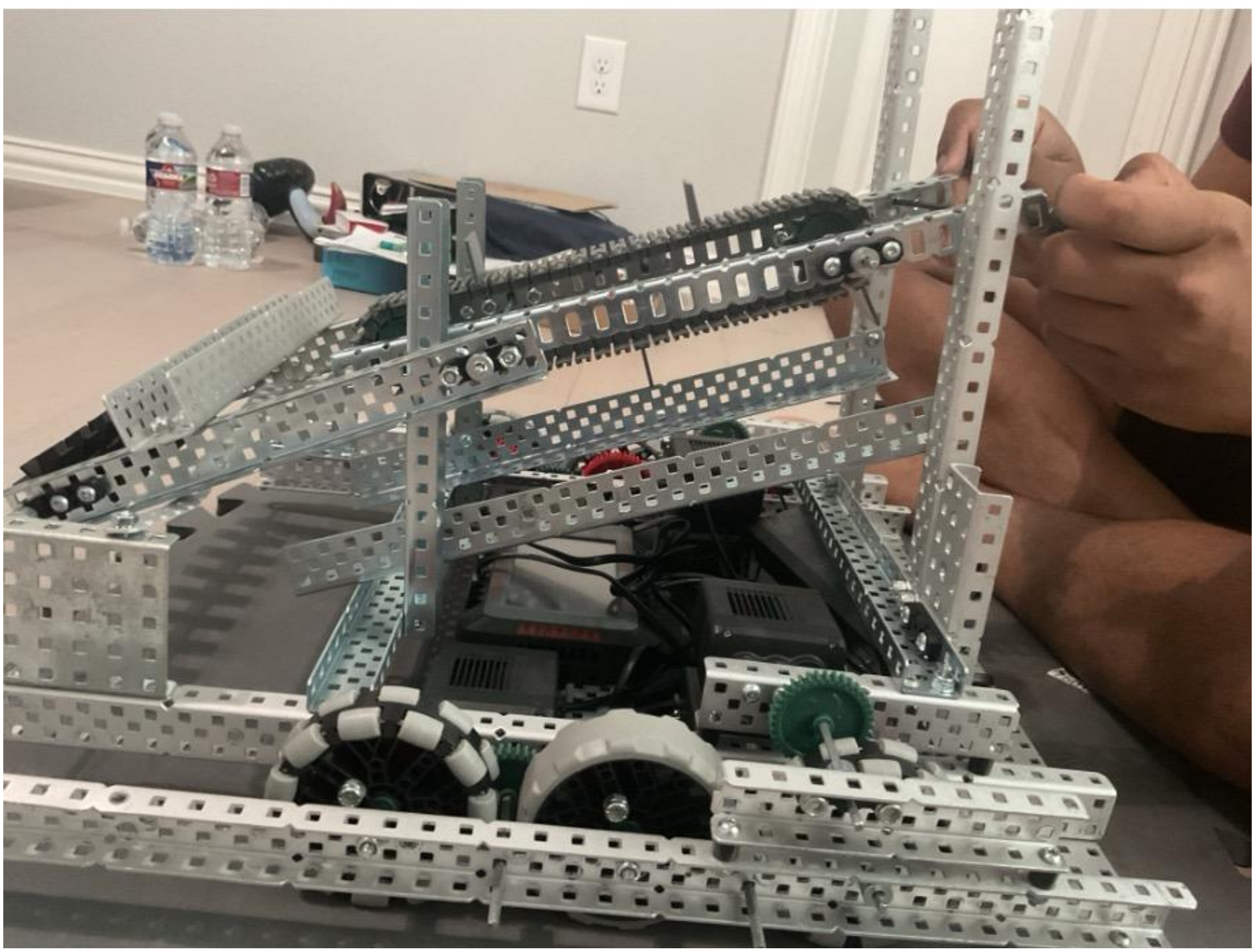
Goal: Make the output of the robot. This will be the point scoring part.

Accomplished:

- While we were able to create an output that worked, testing it showed that we couldn't connect it due to materials and other problems. The robot cannot be completed until this is finished.

Observations:

- We lacked the materials to connect the input and output parts.
- The main problem came down to angles. At it's current angle, the output cannot push balls into the goal, due to the goal being taller than the bot. Because of this we will have to prototype a new output.



Ninth Meeting (cont.)

THE SOLUTION:

- We will move the conveyor belt up 4 holes so that the balls can move up the chute and into the output/goals. This will also mean we will have to extend the track to make it functional.
- We will also use a gear system to make the intake extension functional. We will likely use a chain drive for the intake extension.

Next Steps:

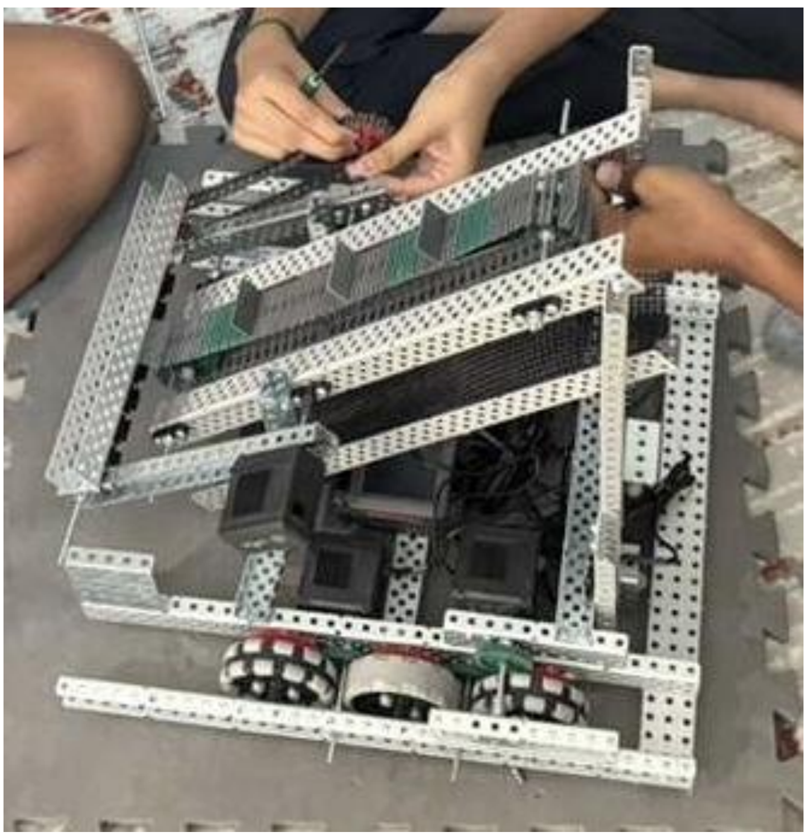
Implement solution. Create a functional output.

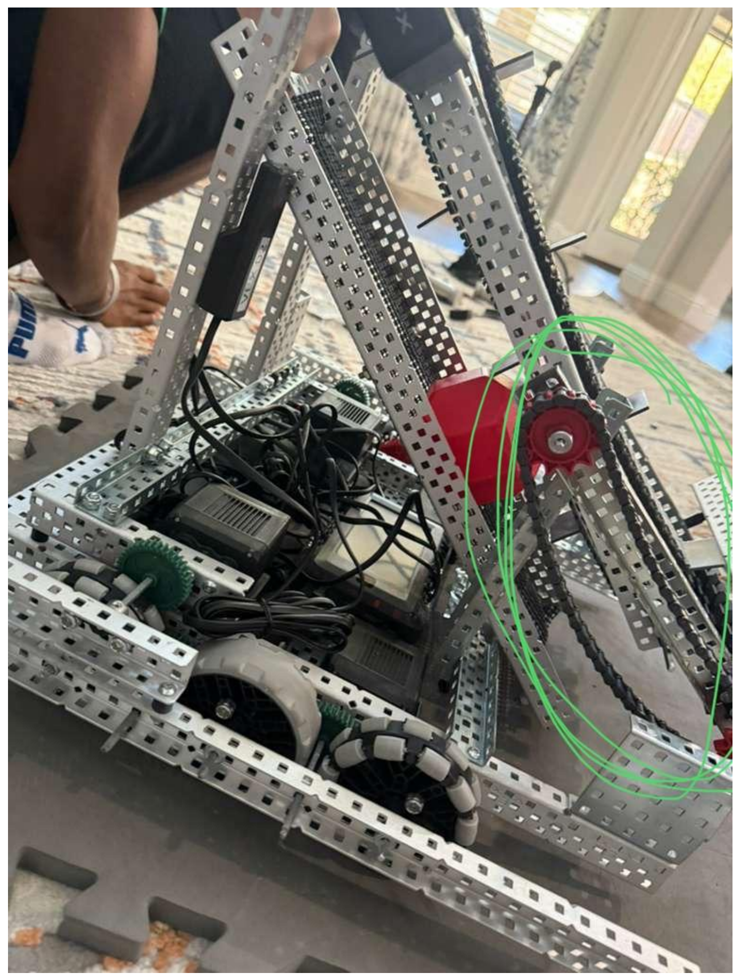
Our Tenth Meeting:

Goal: fix the output and make able to score.

Accomplished (step by step):

1. We started by eviscerating our robot. We kept the frame and drivetrain but removed the intake and the conveyor belt.
2. Next we formed the frame for the top half of the bot. This does not include any of the mechanics that will push the balls out, just a taller frame and supports.
3. Next we reattached the conveyor belt at it's new height and angle. The new conveyor belt is a bit longer.
4. We then added a motor and axle to the red chain drive for the intake extension.





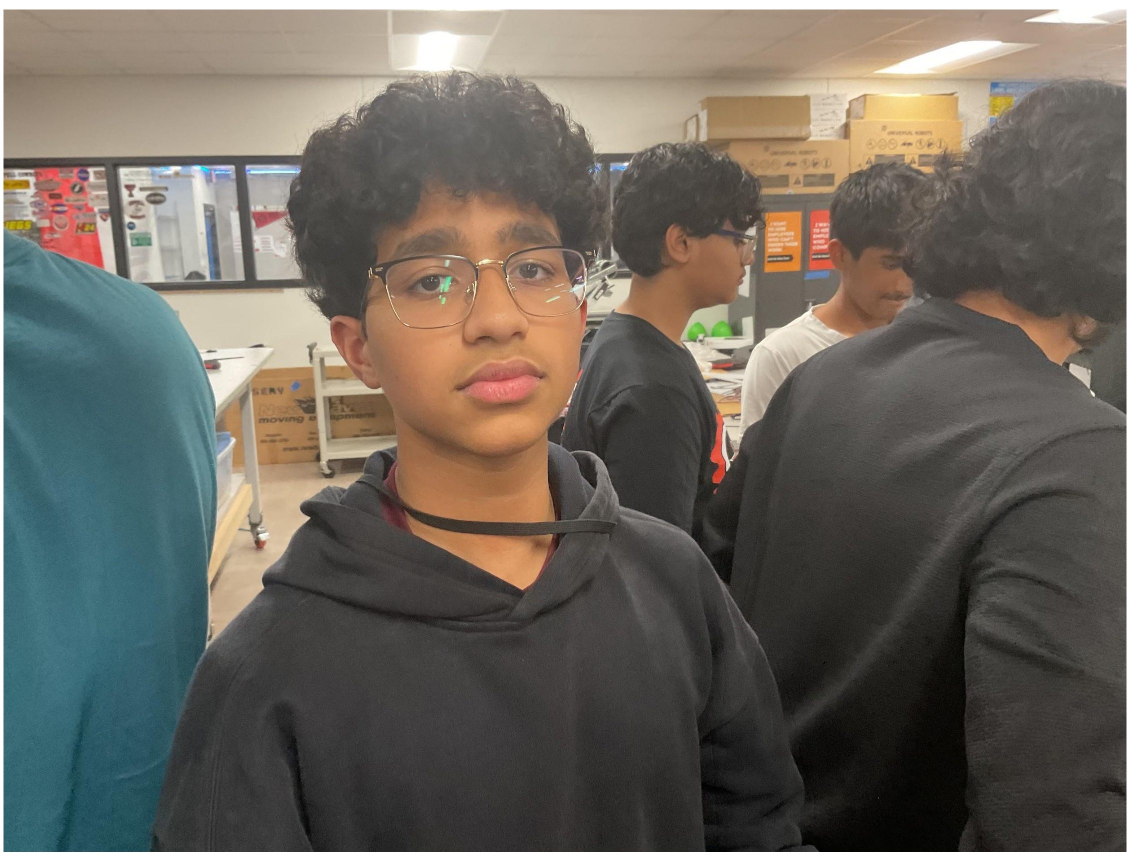
Tenth Meeting (cont.)

Observations:

- In order to remove balls from the tower, we will need to create a new mechanic for the intake. Our current intake is incapable of taking balls from the tower.
- We may want to cut the excess axle off the sides of the bot, as the bits of axles hanging off the side might disqualify us for robot width limits.

Next Steps:

Wire up motors as well as fixing the intake. The intake might not happen immediately, as our builders may not all be present next meeting. However our Electronics Expert (Saharsh) will be able to wire up motors to the brain.



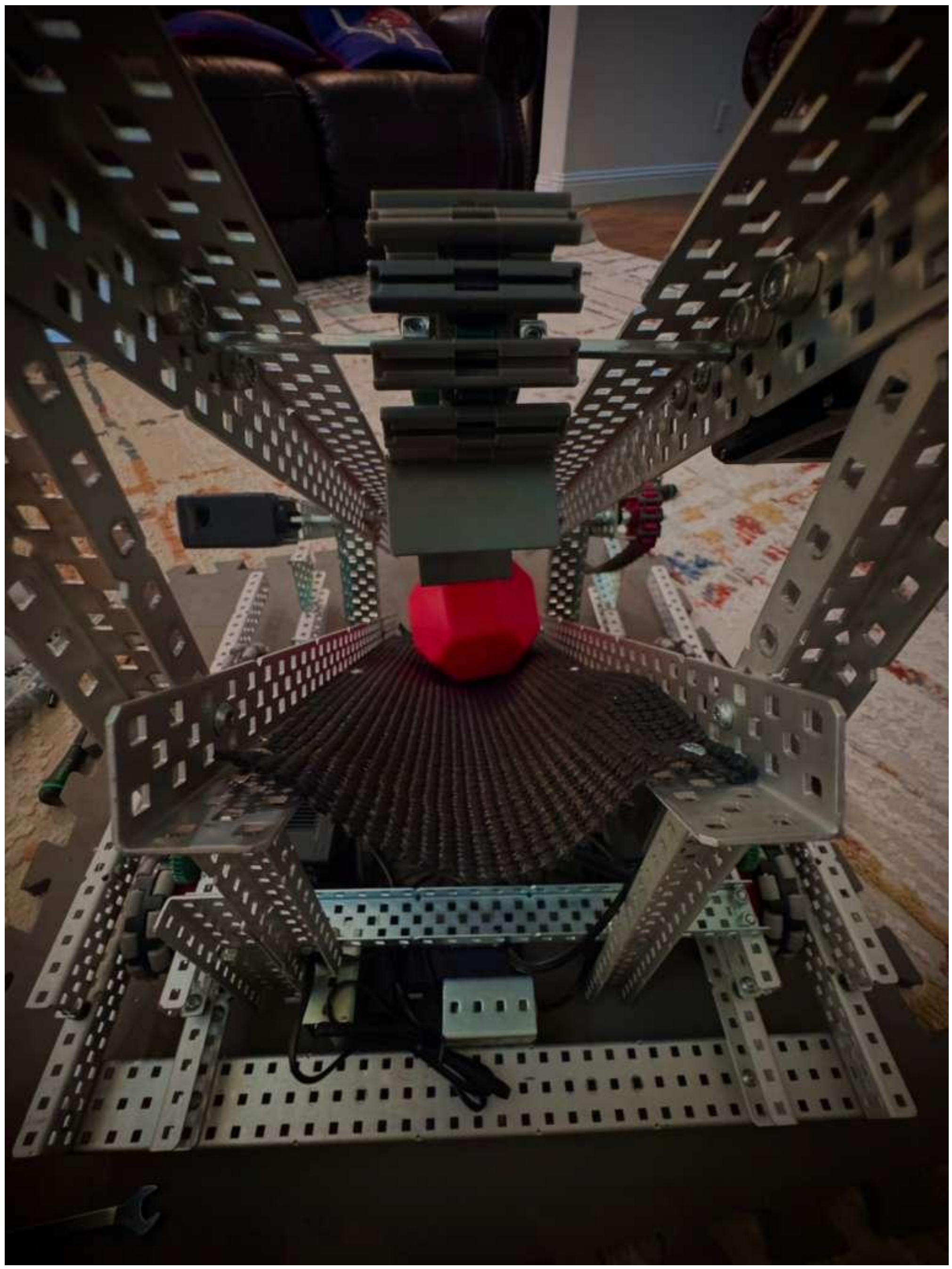
Our electronic expert contemplates wires

Our Eleventh Meeting:

Goal: Wire up motors and fix intake

Accomplished:

- We successfully attached all motors to the robot and wired them to the brain. We can now drive the robot and test it on the field.
- Our robot can turn the conveyor belt, drive, and turn intake extension. This allows us to start driving and testing autonomous.



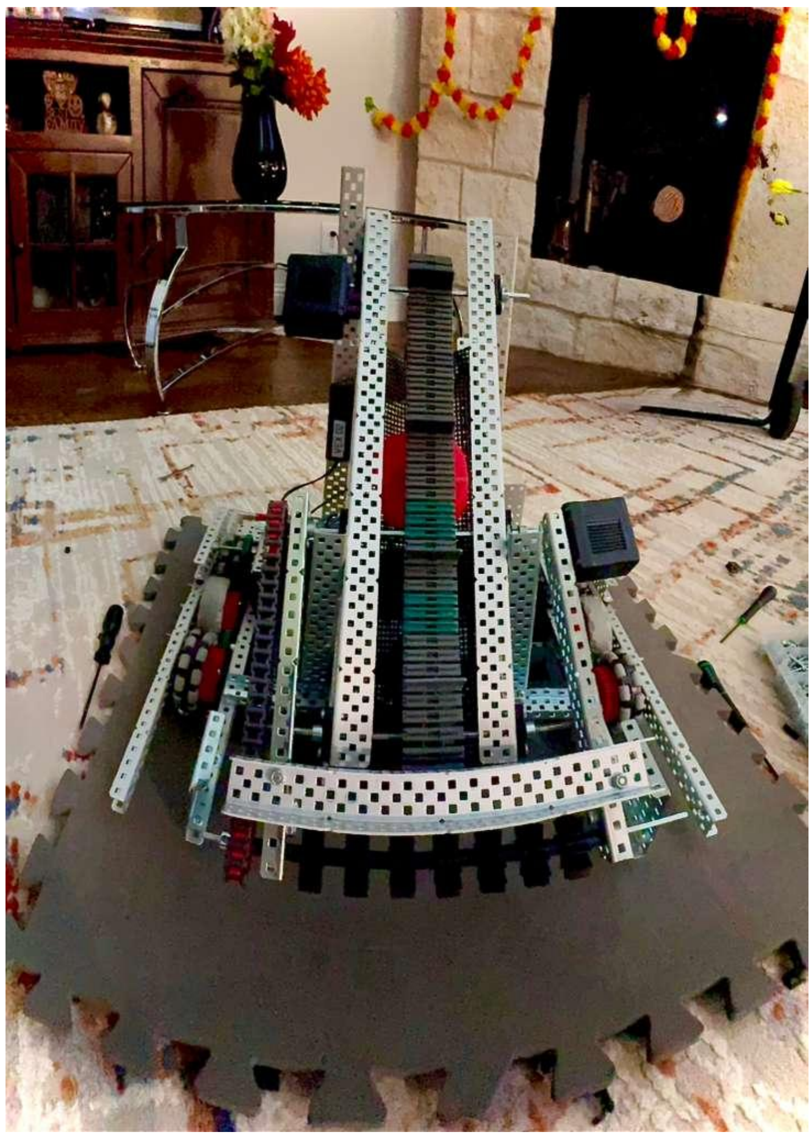
Observations:

- This process took quite a while due to technical difficulties and difficulty regarding placement of motors. Due to the length of this part of the meeting, we did not have time to design a pneumatics system or fix the intake.

Eleventh Meeting (cont.)

Our accidental crime:
The felt we purchased to add as a back to the input chute has turned out to be illegal (in regards to robotics not the law). It is illegal because we purchased it from a non-VEX source.

Next Steps:
Create the pneumatics mechanisms, fix intake so it can take balls from tower, work on autonomous code.

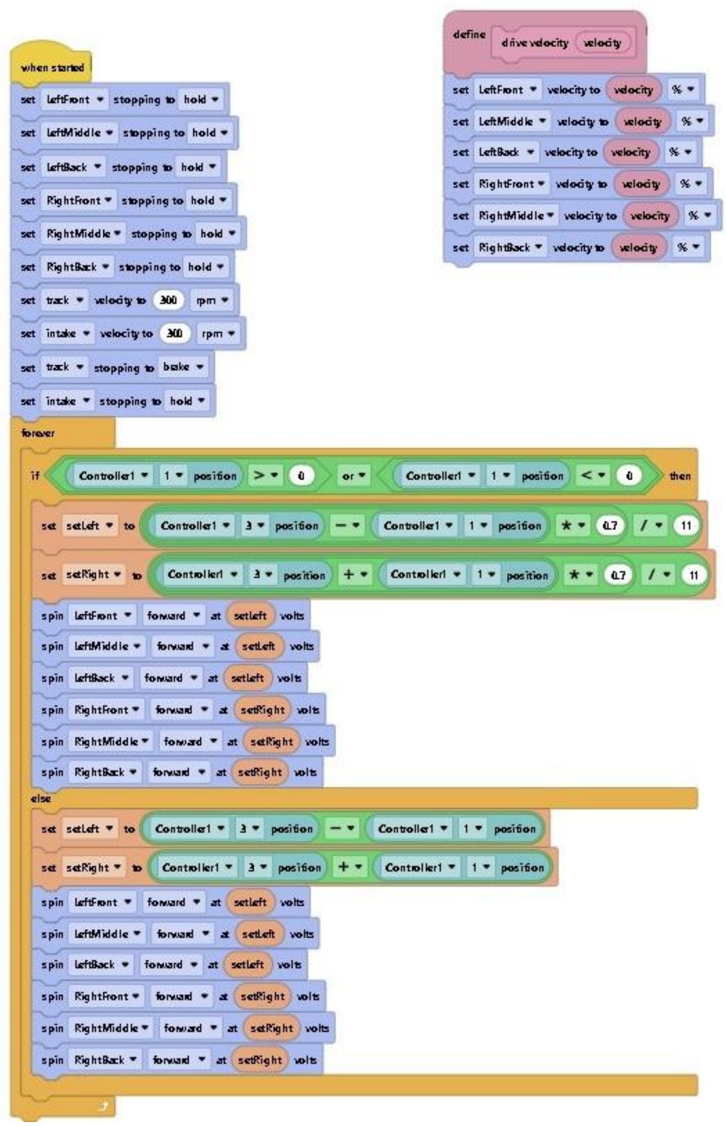


Our flawed but completed bot. We have a bit of fixing, testing, and training left to do.

Our Twelfth Meeting:

Goal: Fix intake to be tower-compatible, create autonomous code.
Accomplished:

- A new design for the intake has been brainstormed by our building lead and building inferiors. They designed an intake that pushes the intake extension into the conveyor belt area and adds a new extension to the intake.
- Autonomous code has been fully created, however it has yet to be tested. This is because we ran out time in our meeting.
- We tested our robot on the field and found that it can suck up balls from the ground but absolutely cannot take balls from the tower.



A sample of our final auton code.

Twelfth Meeting (cont.)

Observations:

- Our new design for the intake cannot be implemented, as Karthik is our team's pneumatics expert. He was the only one who did the research on pneumatics and is the only one who understood the pneumatics design.
- Autonomous code has not been tested, so while it is created it has not been certified as functional. This is the same for our driving. Noah has had no driving experience unfortunately.

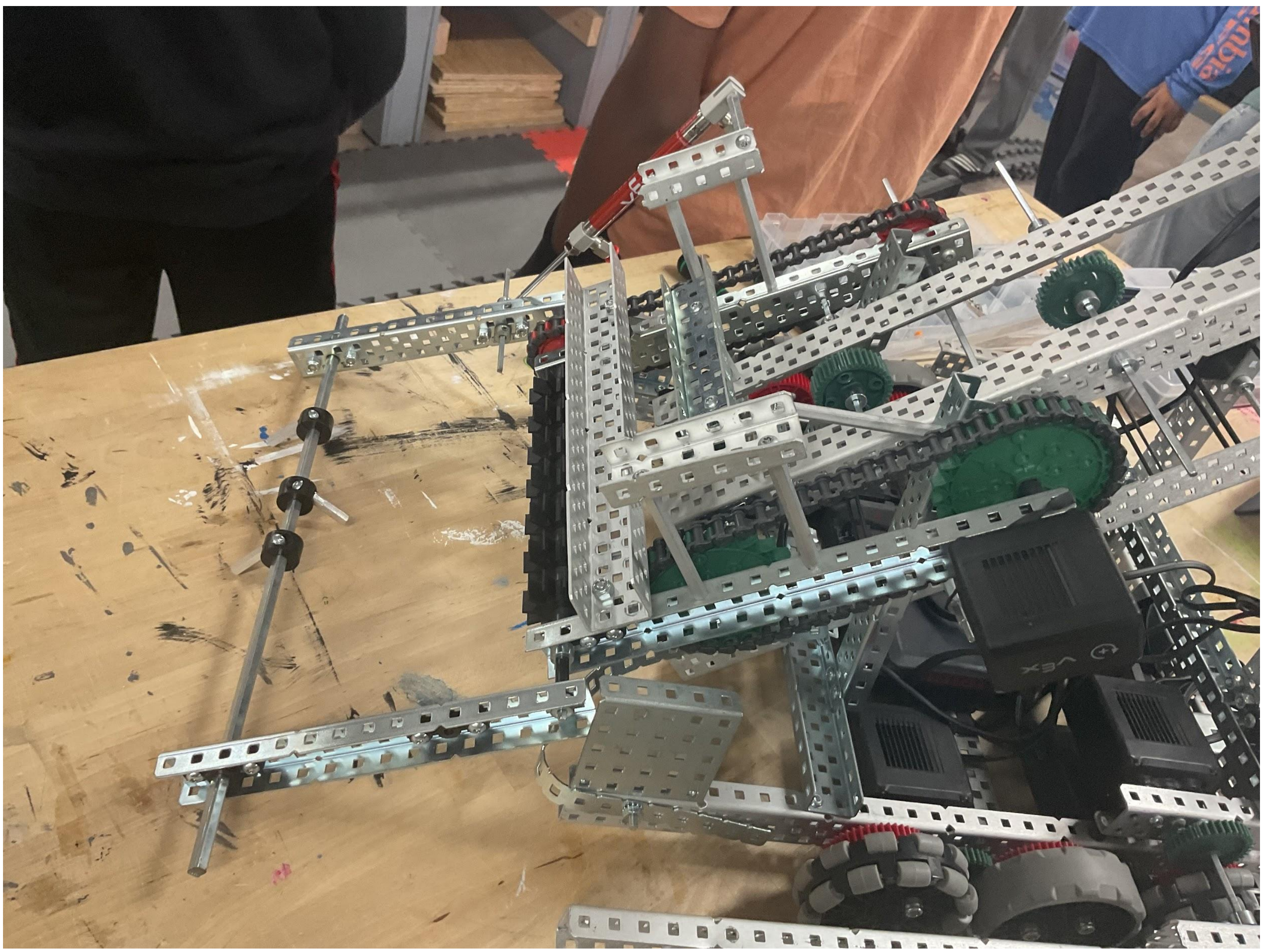
Next Steps:

Test autonomous code, implement new design complete with its pneumatics.

Our Thirteenth Meeting

Goal: start finishing the intake and finishing autonomous.
Accomplished:

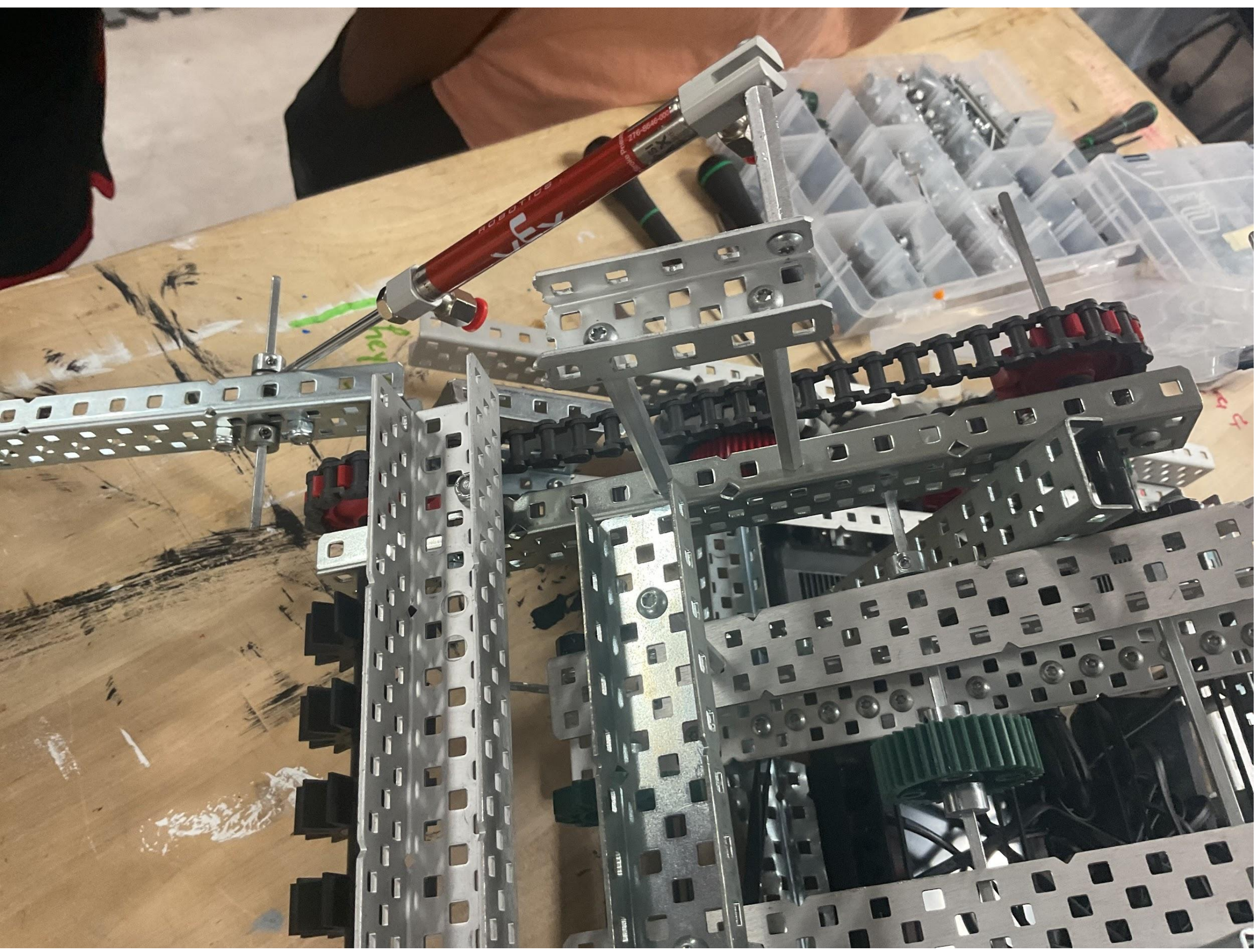
- We started by removing the conveyor belt and pushing the current intake extension into the fixed intake.
- We the connected the intake fan to the conveyor belt via a new chain drive system.
- We then added some bent pieces to guide balls into the intake.
- The new intake extension is made to grab balls out of the ball towers. The pneumatics can push it down from a folded position.



Thirteenth meeting (cont.)

Observations:

- The new intake extension may make the fully expanded bot over 22”. This must be fixed or we will fail inspection.
- We still need to put on the conveyor belt, as well as fix the back of the chute. We removed the rubber bands from the chute, and purchased some legal felt.
- The pneumatics on the intake extension may not be necessary, as we may shorten the whole extension in a later meeting.
- We need sprockets to turn the conveyor belt, right now we have placeholder gears on the axles to show where we need them.



This shows our pneumatics, and chain drive systems.

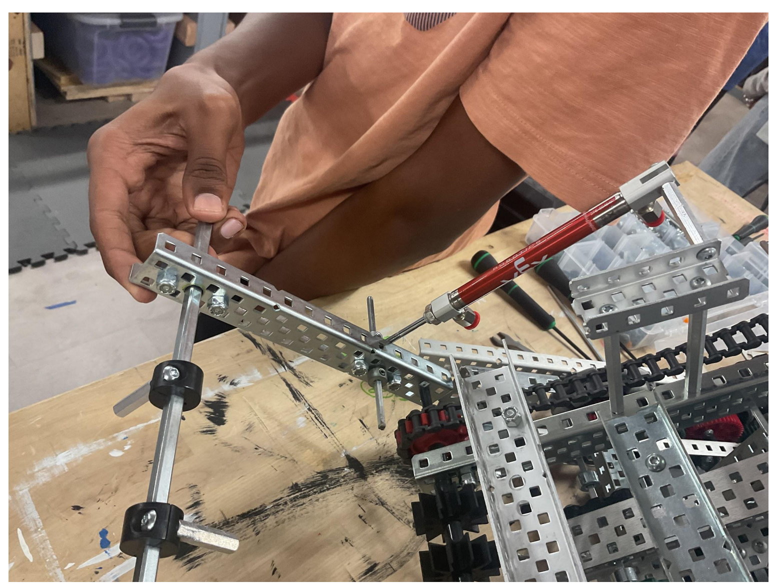
Next Steps: We will complete the intake and put the back on the chute.

Fourteenth Meeting:

Goal: finish intake, try autonomous code, replace the back of the chute.
Accomplished:

- We put on the new conveyor belts, which is now in two segments. We tested it with some balls and it worked just fine.
- We used the legal felt to replace the back of the chute. This felt works great and won't get us disqualified, which is amazing.
- We are going to scrap the current intake extension. We measured it fully expanded, and it was bigger than 22”. We are thinking about pushing the extension backwards, or scrapping it entirely and relying on ground balls for points.

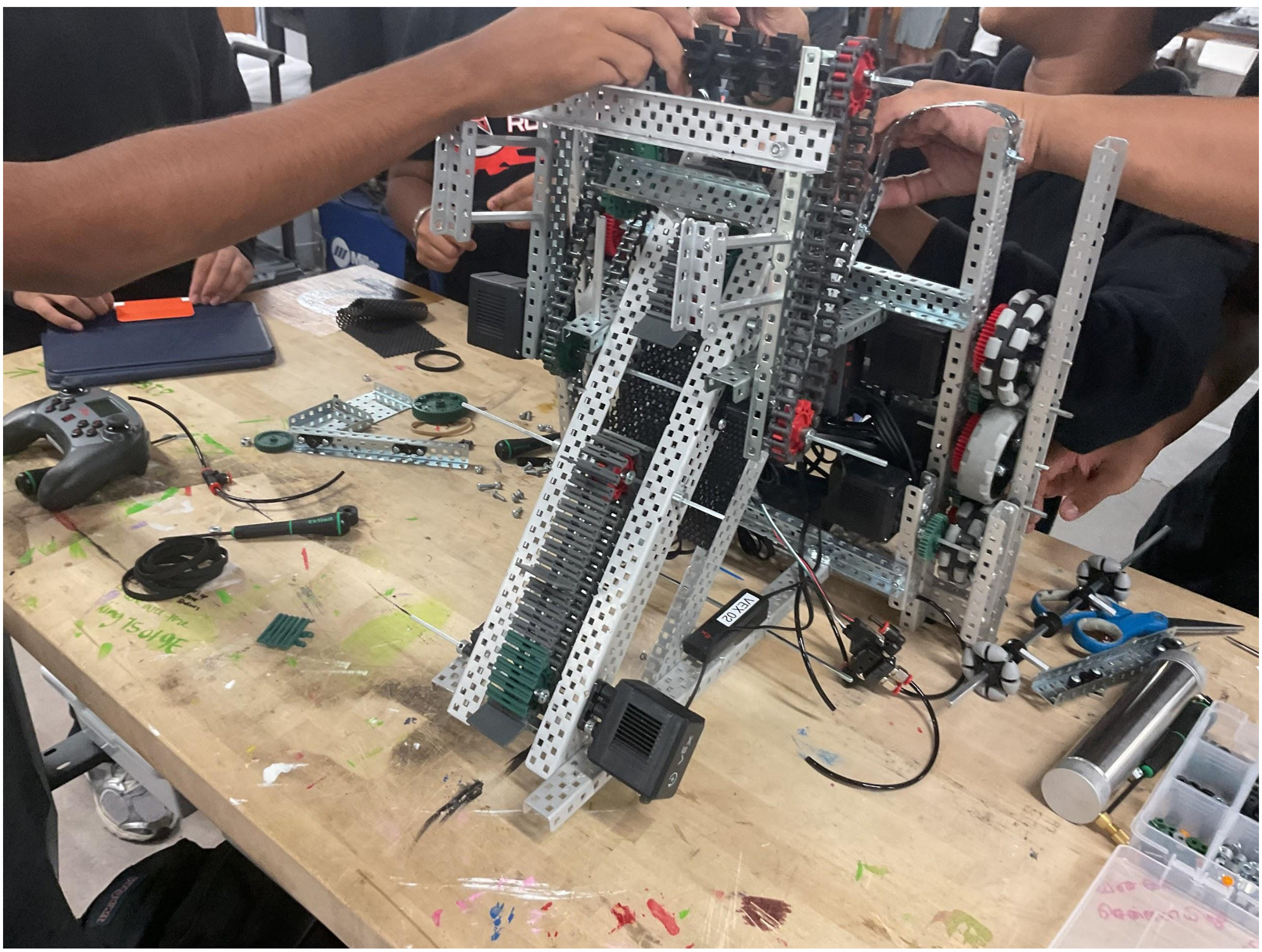
The images below (left to right) show Saharsh screwing felt into the bottom of the intake. In this photo you can see the bent pieces we installed to guide balls into the intake. The image to the right shows the intake extension that is doomed. It should be able to remove balls from the tower, but it is too big.



Fourteenth Meeting (cont.)

Observations:

- After taking off the intake extension, the bot can pass inspection but can't take balls from the tower.
- Autonomous code is lost and we cannot access it. I (Adam) am not totally sure what is wrong with it, but it sounds like the file is inaccessible for some reason. Because of this we may not be able to do any autonomous on the 1st.



Fifteenth Meeting:

Goal: Tweak robot to it's best, test code.
Accomplished:

- We are planning to change our motors to blue motors so we can increase speed. This will require us to find some blue cartridges and use them tomorrow in the lab.
- We got the auton code working. It was tested and all of it works. See below.

Observations:

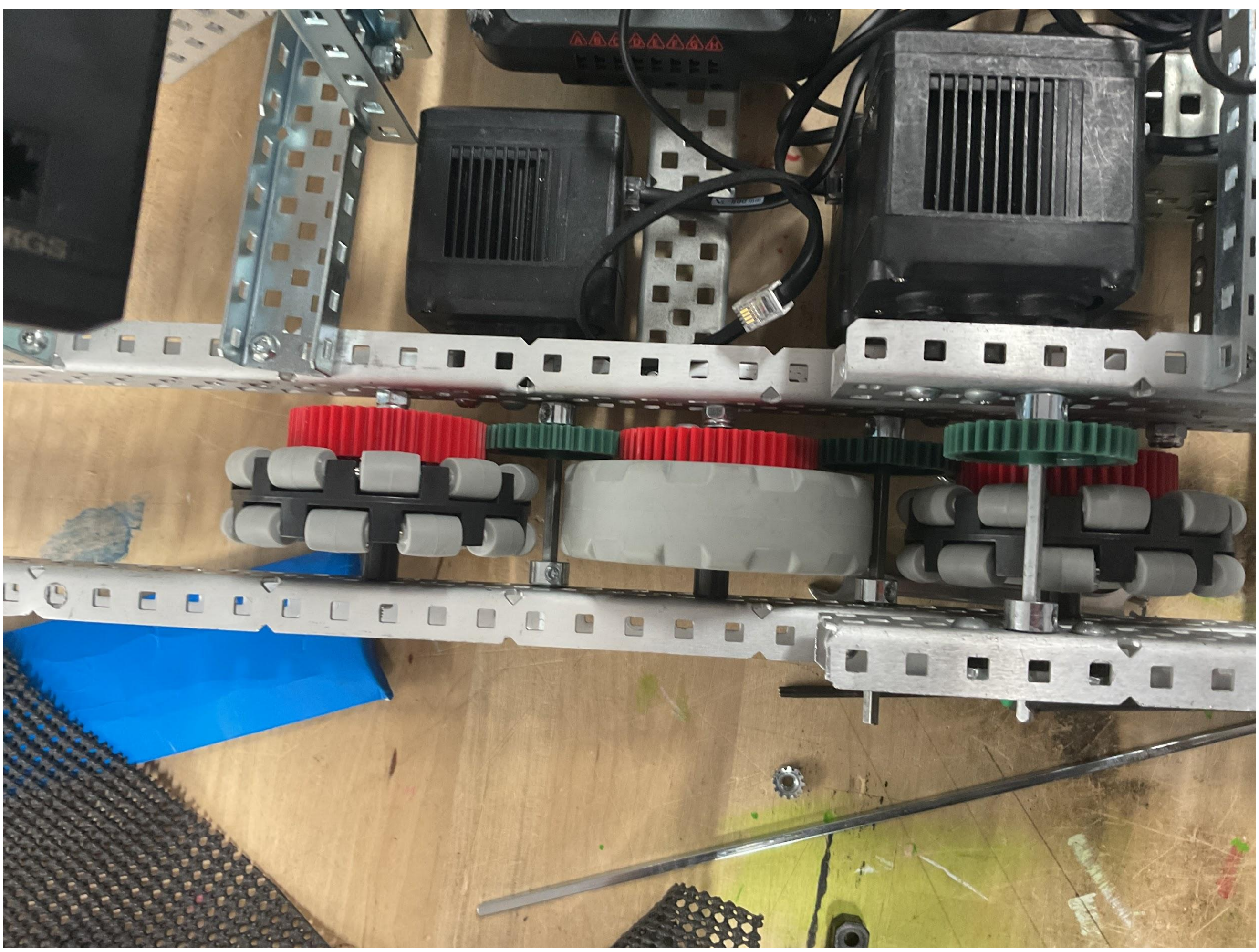
- This will be pretty much the final tweak before first comp.

Section E

Final robot for first competition

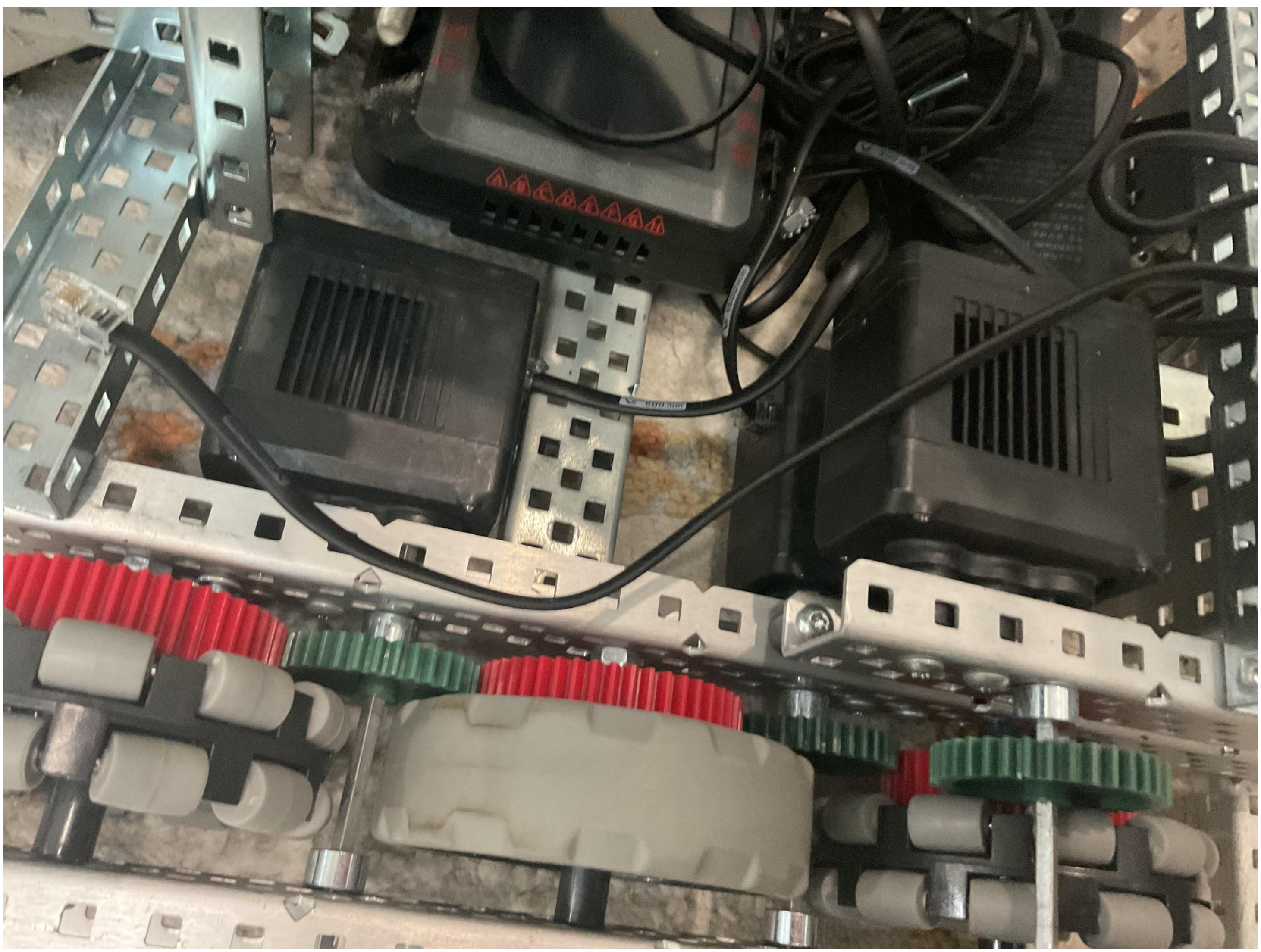
Drivetrain

Our drivetrain uses a 6 wheel system with 4 Omni wheels. 2 Omni wheels in the front and 2 Omni wheels in the back. We used 4 Omni wheels so the bot can go fast but we also wanted to give it controle because if we only had Omni wheels we would have speed but we would not have stability and the bot would not have good grip on the ground making it easy to tip our bot over and for this we added 2 friction wheels. Having a 6 wheel also helped us with balancing or bot and also allowed for our bot to be easy to control.



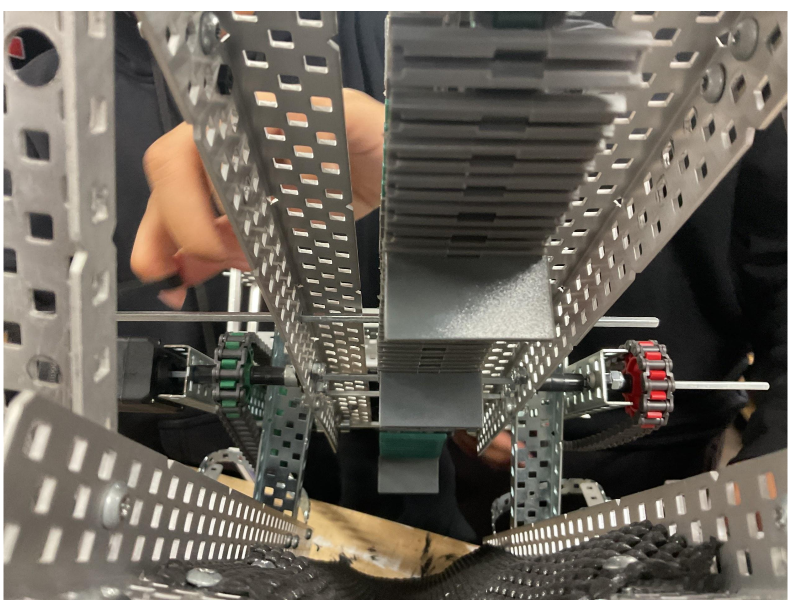
Drivetrain continued

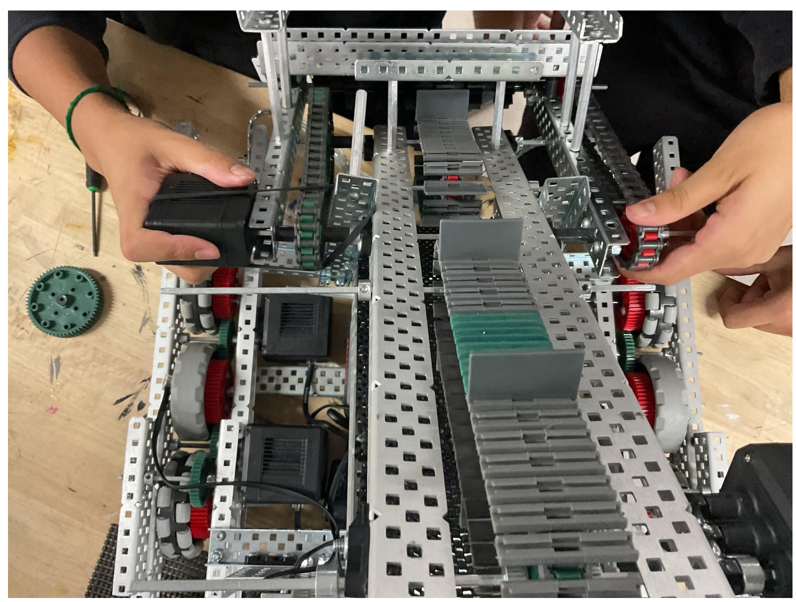
We used a 6 motor drivetrain for 2 reasons. The first one being we have 6 wheels requiring us to use 6 motors along with this the 6 motor drivetrain would allow us to gain speed quickly and go a certain part of the field this way other teams are less likely to go for the same area as us because it would be easier for them to go to a different area allowing us to quickly



Track

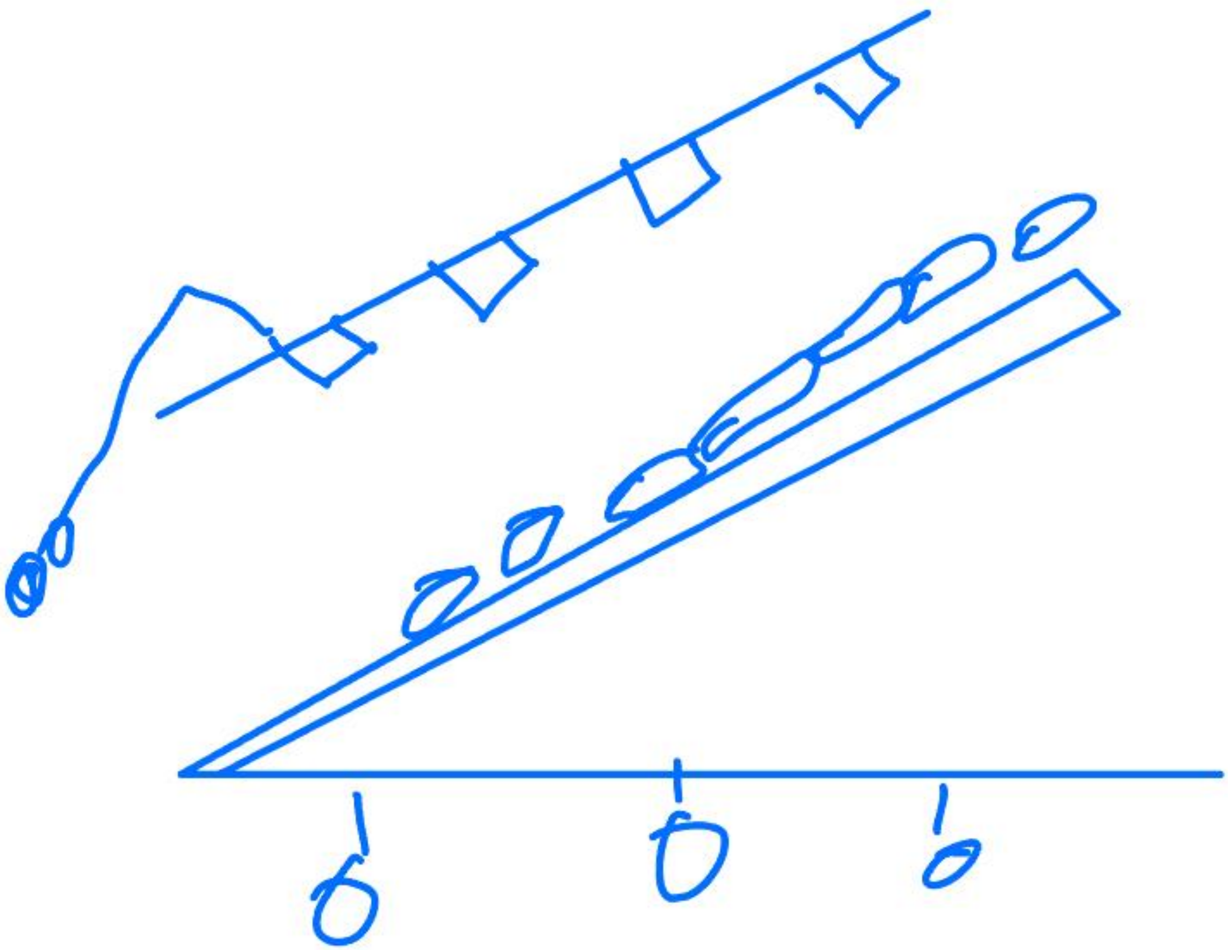
We need track because we need a way to take the blocks from the intake and send them to the top of our bot where the blocks will be unloaded into the goal for us to score points. Track was the best option for this because we wanted the blocks to enter the bot from one side and exit from the other and we wanted to be able to easily control blocks and stop them when needed for when our robot is going from the loading station to the goal. We need this control because if we could not control the blocks they would either fall out of the top or the bottom.





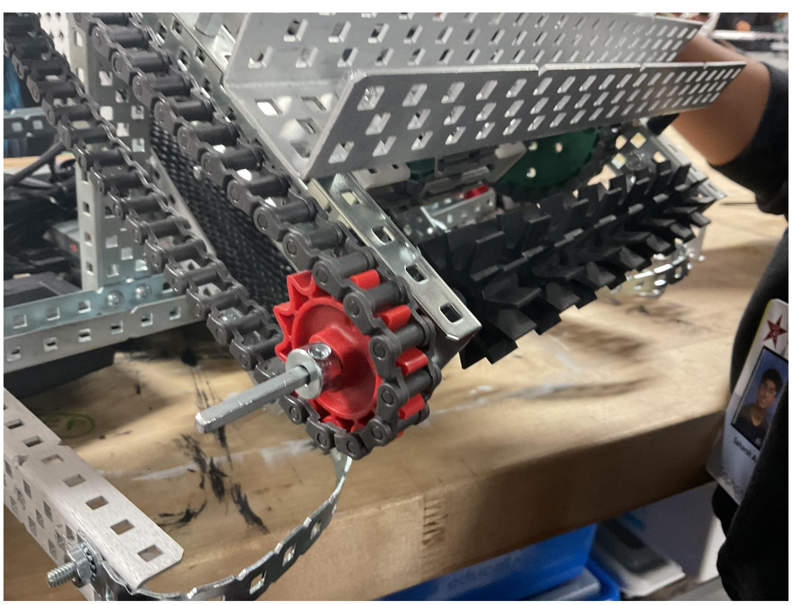
Track

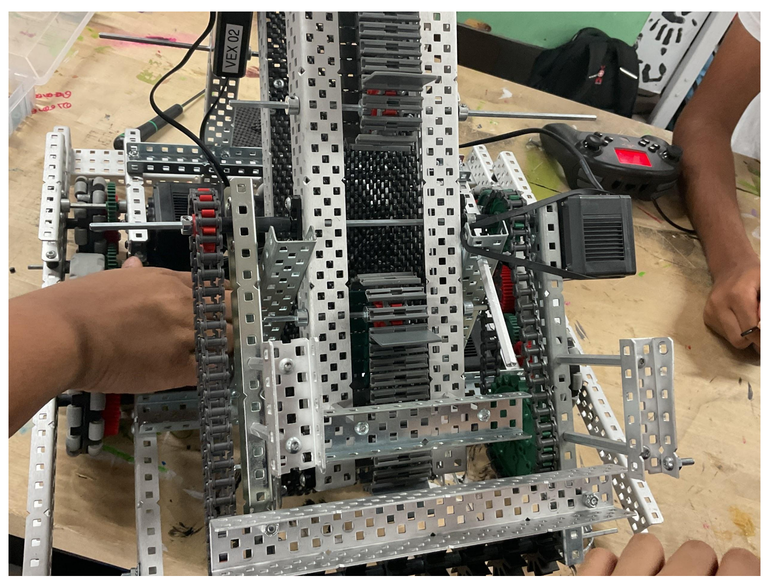
If we just places track the blocks would not have gone up the track efficiently because of this we paced rubber bands under the track so that the rubber bands will hold the blocks up while the track will take the blocks up.



Intake and how we improvised

Originally we planned to use the intake from the hero bot as it was efficient and fast and it could quickly take blocks from the tiles and from the loading station but we had a problem we did not have time and space to add this intake so we improvised and quickly made a intake with intake rollers but this intake was primarily focused on taking blocks from the tiles and could not take blocks from the loading station to fix this problem we made an extension to our drive train so that it remover the blocks from the loading station and then our intake can collect the blocks.





Coding

Originally we planned to use C++ on the provider easy template pros but due to us not having an IMU(inertial sensor) we had to code in block code we. Because we used block code we had to assign each motor a name and spin all of them at the same time based of the controller axis and position because block code does not allow us to make a 6 motor drive train

IMU

Section F

Things to improve

Intake

though our intake works it could be more optimized. We could have done this by using 2 traction wheels in a 45 degree angle vertically with one traction wheel on each side and the motor for each traction wheel under the wheel. The reason this would be a better intake is because it would allow for a faster way to take the blocks into the holding area of our bot and it would allow us to easily get blocks from the loading station.

Drive train

We could have improved our drive train by adding more distance between the wheels this way our bot would have been less susceptible to other bots hitting our bot because if the wheels were farther apart the robot would be more well balanced

Next Steps:

Track

We could have improved the track by making its top area wider and making it to where we would have 2 tracks side by side this way we could have taken advantage of our wide base. This would have allowed us to have a robot with more space to hold blocks while also making it easier to score goals.

Next Steps:

Section G

Reflecting on competition and planing what to do

Reflection

The competition was our debut in this VEX season as team 75109E, and we had a rocky start in the competition, as we lost our first 2 matches in the tournament. The bot just wasn't capable enough to score points as the balls that our bot picked up kept getting stuck in the crevices of our intake. Also, we didn't have any pneumatics in the bot to push the balls upon the platforms to gain points. Our bot was also slanted to the left, so even if the balls actually went past the intake, the balls were flung in the wrong direction, missing the platforms. Finally, our autonomous code began bugging and in auton, our bot just stood still instead of what our coders coded the bot to do. In our 3rd match is where we finally catched a glimpse of success as we won

Next Steps:

Track

We could have improved the track by making its top area wider and making it to where we would have 2 tracks side by side this way we could have taken advantage of our wide base. This would have allowed us to have a robot with more space to hold blocks while also making it easier to score goals.

Next Steps:

Section H

Our drive train for S design

What we want in our drive train

- Maintain stability while driving and turning
- Good traction for pushing other robots
- Support reliable acceleration
- Good control over the bot
- High speed
- Low chance of the bot falling over
- Easy navigation during auton
- Low chance of anything breaking due to impact

Next Steps: Brainstorming

Options to choose from

Number of Wheels

- 4 wheel
- 6 wheel
- 8 wheel

Number of motors

- 4 motor
- 6 motor

Attachment options

- Screw joints
- Axils

Next Steps: weighing pros and cons

Number of Wheels

4 wheel (generally 4 motor)

- Easy to code
- Not enough speed when using 4 motor
- Hard to use gear ratios
- Easy to control
- More susceptible to breaking

6 wheel(generally 6 motor)

- Less balance
- Not enough speed
- Easier to build
- Easy to set up
- Traction

Next Steps: weighing pros and cons

Number of Wheels

8 wheel (generally 6 motor)

- Hard to code
- Hard to build
- High speed
- Easy to control while driving
- Traction
- Balance
- Weight distribution

We took a team vote and decided that using 8 wheel would be best. As it would allow for better speed and weight distribution compared to 4 or 6 wheel. We felt that the only downside of using 8 wheels would be that it is harder to build and code.

Next Steps: Prototyping

Next Steps:

How we solved all the problems

We decided to go with an 8 wheel drive train so that it is stable and does not fall over during the game this would also allow us to get high traction and better weight distribution compared to a 4 or 6 wheel drive train. We decided to use 3 omni wheels and 1 traction wheel on each side with 2 omni wheels in the front followed my 1 traction wheels followed by 1 omni wheel. We did this because it would allow us to have traction while also giving us the capability to move easily.

Next Steps:

Track

We could have improved the track by making its top area wider and making it to where we would have 2 tracks side by side this way we could have taken advantage of our wide base. This would have allowed us to have a robot with more space to hold blocks while also making it easier to score goals.

Next Steps:

Track

We could have improved the track by making its top area wider and making it to where we would have 2 tracks side by side this way we could have taken advantage of our wide base. This would have allowed us to have a robot with more space to hold blocks while also making it easier to score goals.

Next Steps:

Track

We could have improved the track by making its top area wider and making it to where we would have 2 tracks side by side this way we could have taken advantage of our wide base. This would have allowed us to have a robot with more space to hold blocks while also making it easier to score goals.

Next Steps:

Project

Name

Date

Full Scale

Project

Name

Date

Page

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

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Half Scale

Project

Name Date Page

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

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Third Scale

Project

Name

Date

Page

PORT 11

PORT 12

PORT 13

PORT 14

PORT 15

PORT 16

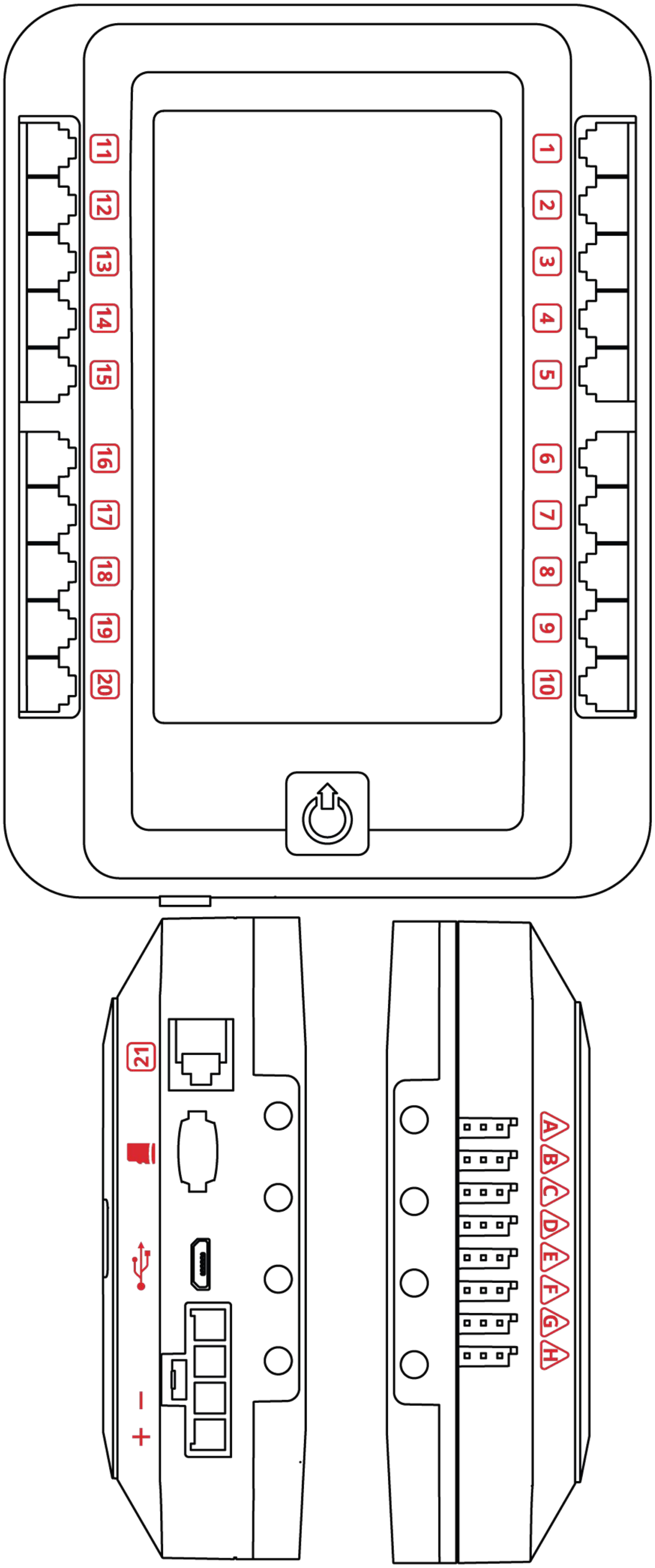
PORT 17

PORT 18

PORT 19

PORT 20

PORT 21



1 PORT

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A PORT

B PORT

C PORT

D PORT

E PORT

F PORT

G PORT

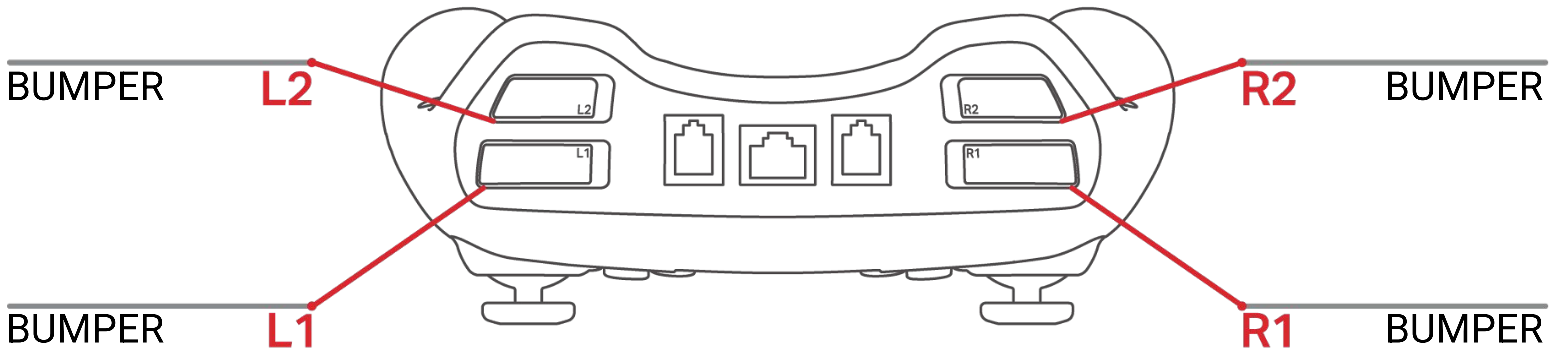
H PORT

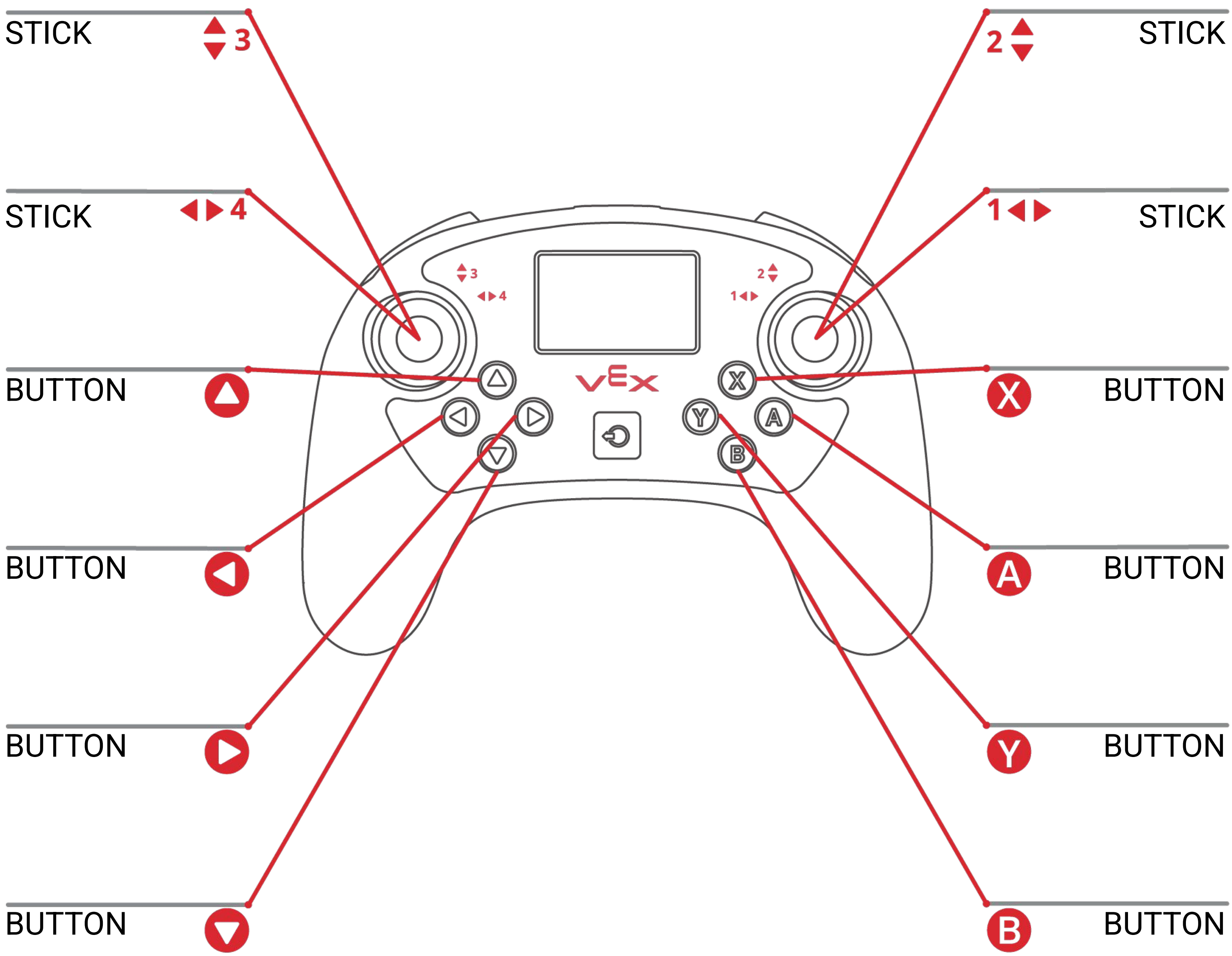
Project

Name

Date

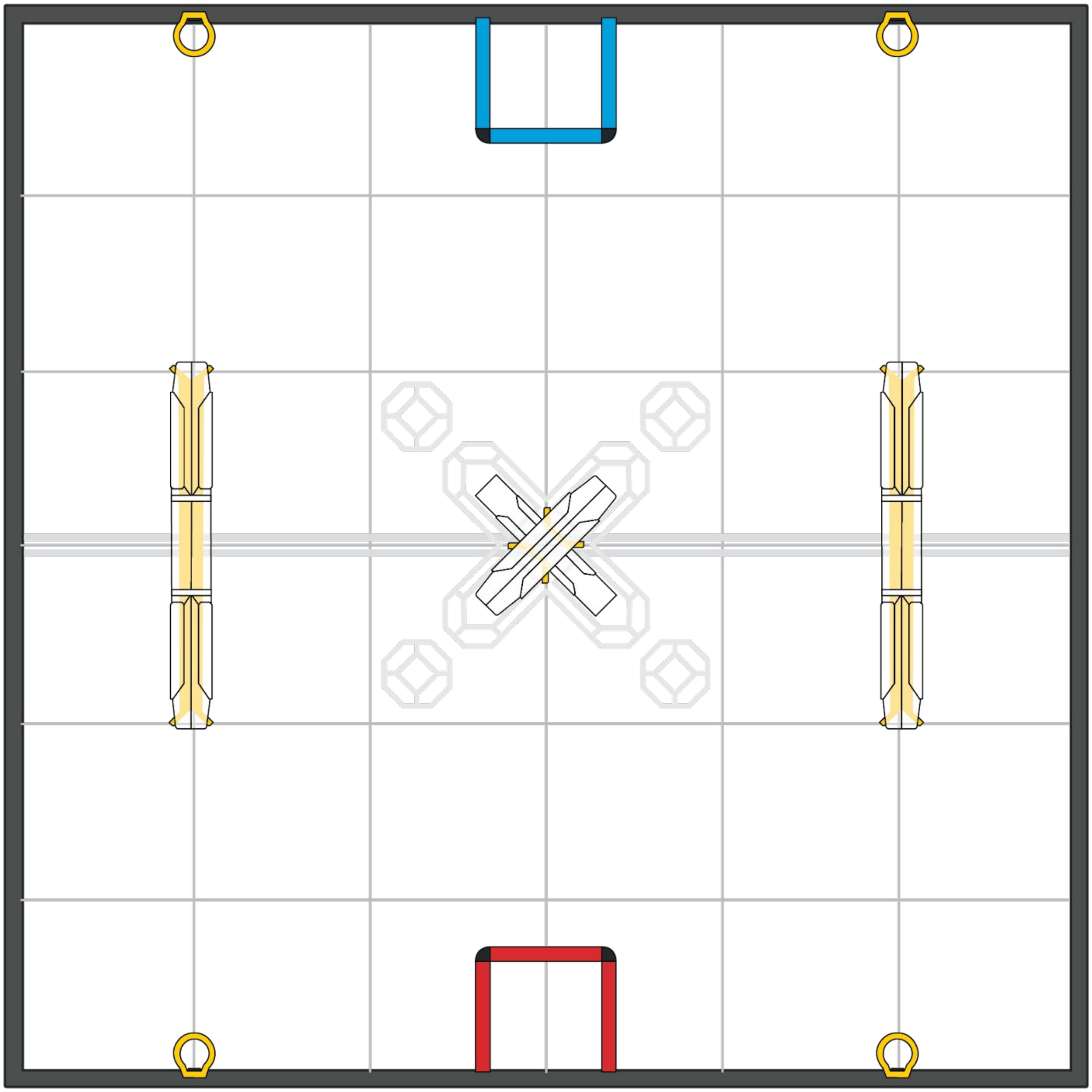
Page





Project

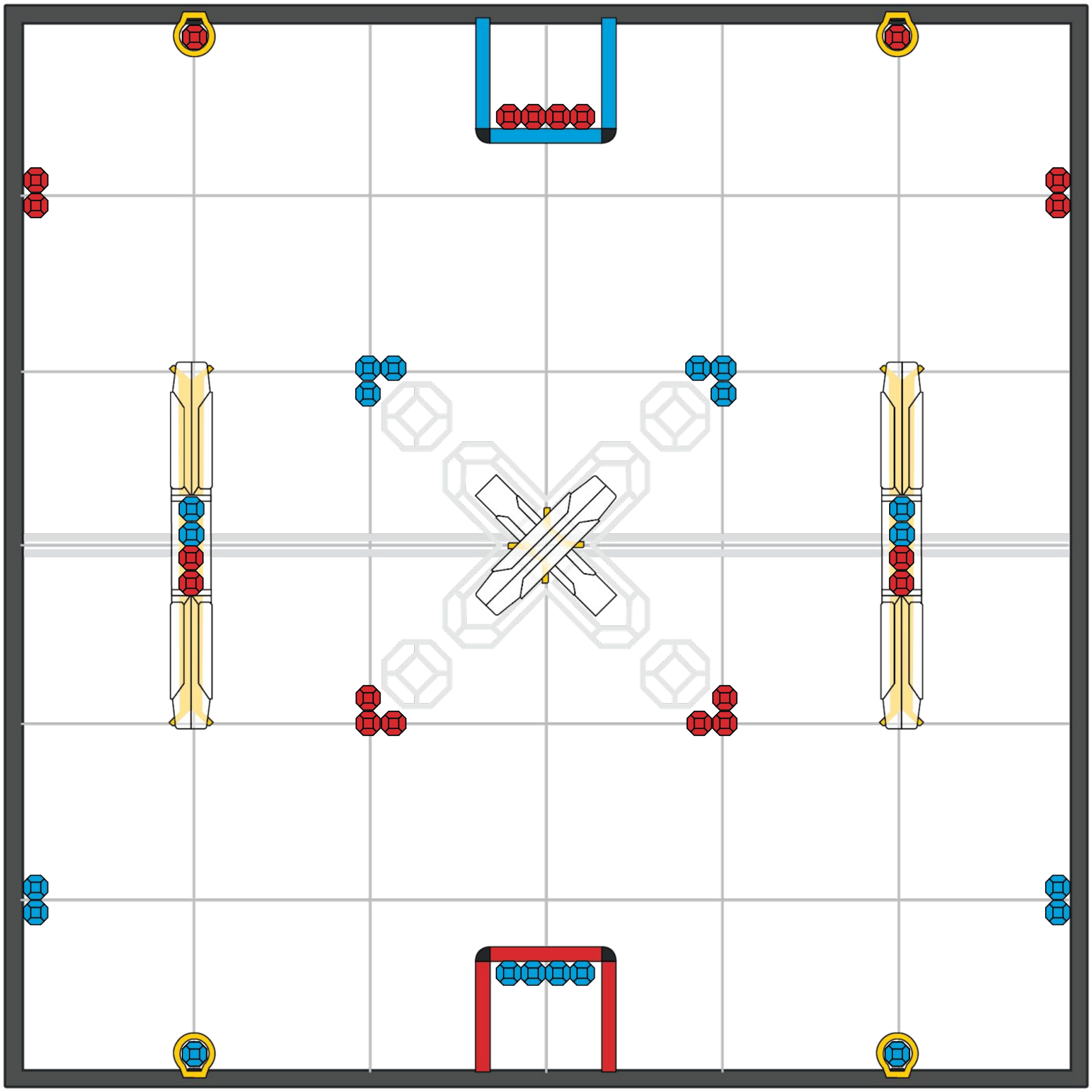
Name Date Page



1/24th Scale

Project “Push Back” Blank Field

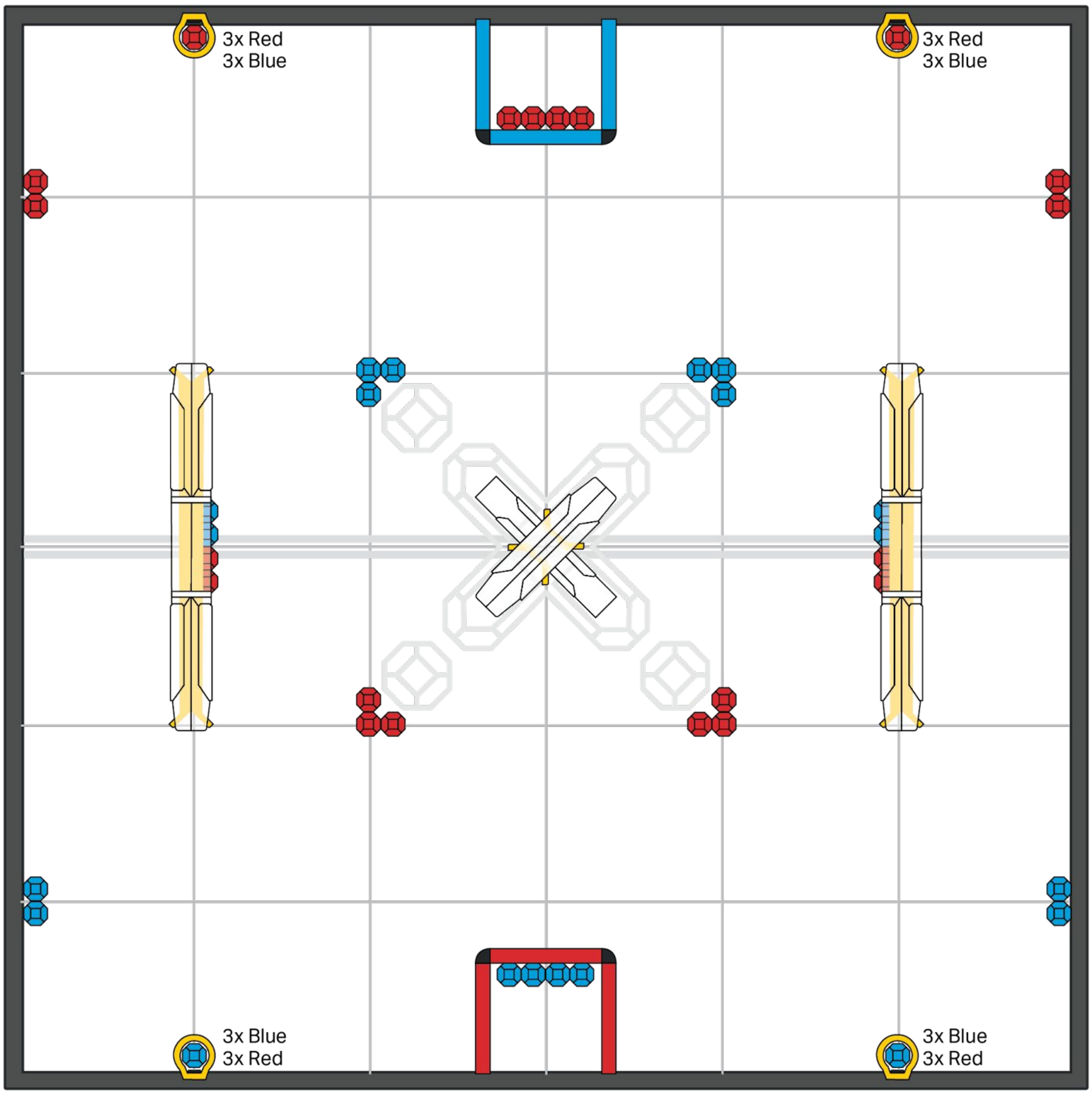
Name Date Page



1/24th Scale

Project “Push Back” Starting Field with Moveable Game Objects

Name Date Page



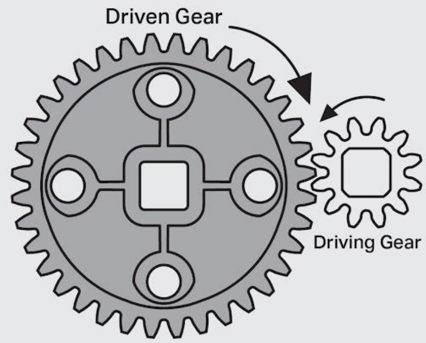
1/24th Scale

Project “Push Back” Starting Field with Static Game Objects

Name Date Page

Gear Formulas

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



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

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

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

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

Motion Formulas

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

Distance is from the **axis of rotation**

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

Circumference = π × Diameter

Power = Force × Velocity

π ≈ 3.14

Torque = Force × Distance

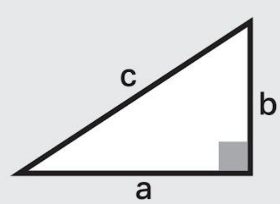
Force = Mass × Acceleration

Mathematical Formulas

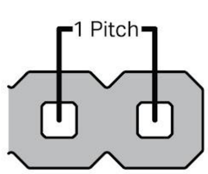
Complimentary angles are angles that sum to 90°

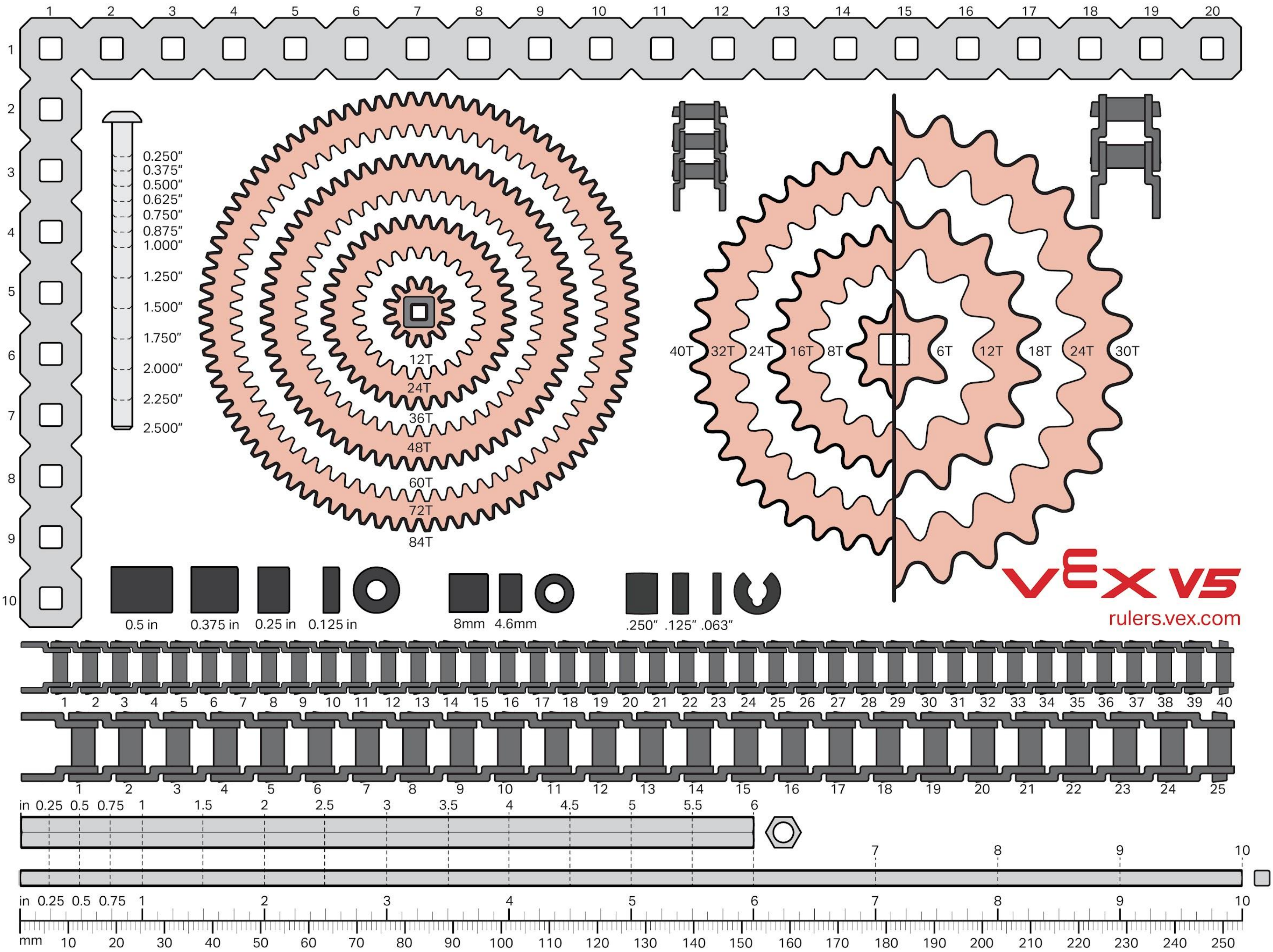
Supplementary angles are angles that sum to 180°

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



1 Pitch = 0.5 in =12.7 mm





0.250″ 0.375″ 0.500″ 0.625″ 0.750″ 0.875″ 1.000″ 1.250″ 1.500″ 1.750″ 2.000″ 2.250″ 2.500″
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.250″ .125″ .063″
VEX V5
rulers.vex.com
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Week of: MM/DD/YYYY

Monday

Tuesday

Wednesday

Thursday

Friday

Saturday

Sunday

Name

Page

May 2025

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Name Page

June 2025

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Name Page

July 2025

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Name .... Page ....

August 2025

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Name Page

September 2025

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Name .... Page ....

October 2025

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Name .... Page ....

November 2025

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Name Page

December 2025

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Name .... Page ....

January 2026

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Name Page

February 2026

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Name Page

March 2026

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Name .... Page ....

April 2026

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Name Page

May 2026

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Name Page

May 2025

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Name Page

June 2025

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Name Page

July 2025

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Name

Page

August 2025

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Name Page

September 2025

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Name Page

October 2025

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Name Page

November 2025

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Name

Page

December 2025

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Name Page

January 2026

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Name Page

February 2026

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Name .... Page ....

April 2026

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Name

Page

March 2026

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Name Page

May 2026

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Name .... Page ....