TRUBOTICS

DESIGN NOTEBOOK

10801Z

10801Z

Team Members

Jake Xia

ENGINEER/ PROGRAMMER

With endless creativity, Jake possess both the artistic abilities of a designer and the brains of a programmer. The beautiful logos on our t-shirts are created by him, and so were majority of our visuals and diagrams throughout. Dabbling a little in every topics, he assists with programming and logic evaluations at times of emergency, thus is the most versatile and valuable member of the team.

Alexis Wei

LEAD ENGINEER

The one with the Steve Jobs mindset that keeps our team on track with our goals. She frequently uses a *reality distortion field* to get us to where we need to be. Knows every detail of our robot and all our team whereabouts. Coordinates and orchestrates all of our operations. Literally present at every single meeting, considering her basement is our headquarters.

Joey Ma

PROGRAMMER

Fierce programmer and is surprisingly (or not so surprisingly) deft at wielder power tools. Very strong, he is our go-to person for screwing and unscrewing nylon nuts. Unsurprisingly, presumably due to his need for energy, he is always hungry. We have him to thank for solving all our problem (or creating new ones) programatically.

Jonathan Hai

DRIVER

Quick thinking and fast reflexes makes Jonathan our team's best driver. When not helping in the building and design process, he's practicing stacking cones and maneuvering the robot. Strangely, he prefers unintuitive tank controls to a simple joystick.

Andy Chiang

SCOUT

Andy is an expert on the human-resource side of robotics. He uses his skills in communicating with people and his abilities in establishing connections to help better our team. At the competitions, Andy works fervently, compiling a detailed list of our potential alliances and robots to look out for.

Anton Liu

ENGINEER

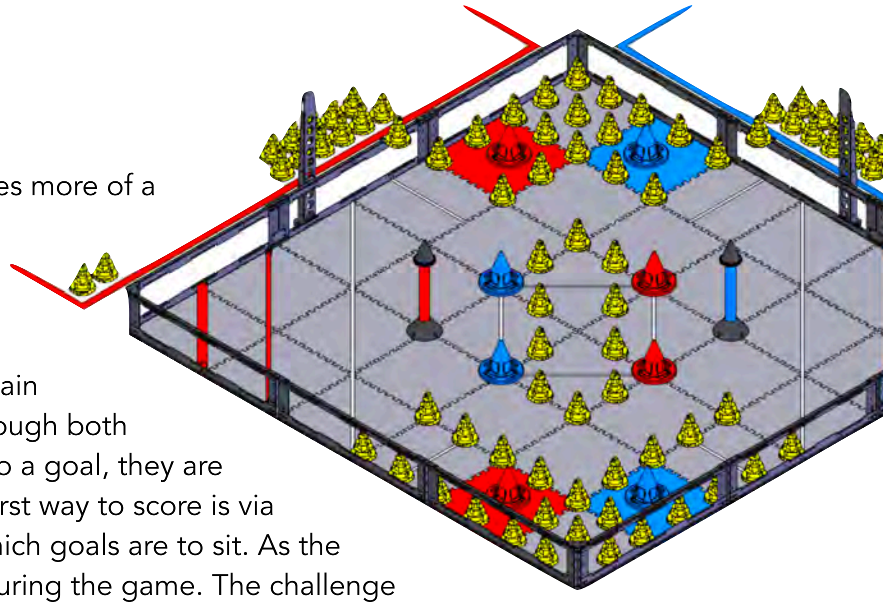
The brains of the operation; Anton worked extensively on the ideation and creation process of our initial design. He conducted research and drew up the original blue prints. Ready for any troubleshooting, he carries a spare Allen key and wrench on him at all times for good luck.

Special contributions from:

Jonathan Yapeter **Shivani Chidella**

THE GAME

In the Zone

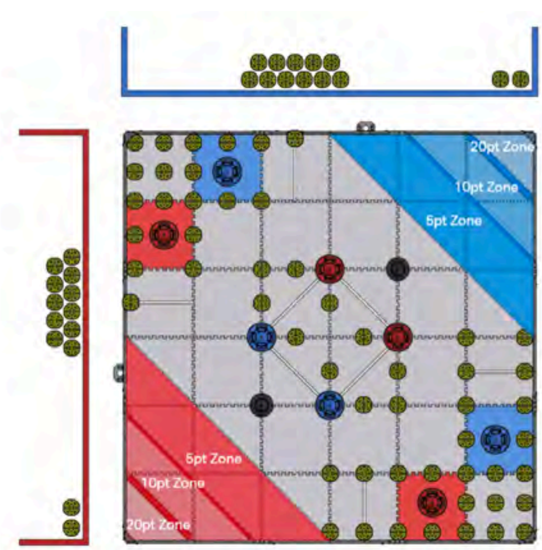


This year's game, In the Zone, is magnitudes more of a challenge compared to last year's. The robots require a lot more versatility and maneuverability.

The game can be broken down into two main parts; the two ways of scoring points. Although both methods require the stacking of cones onto a goal, they are fundamentally different in approach. The first way to score is via stationary goal, an elevated platform of which goals are to sit. As the name suggest, these goals do not move during the game. The challenge they pose is only their height. The more exciting element to this game is the mobile goals. Not only must the robot stack onto these goals, the robot must also have a means of transporting the goals to the various scoring zones. The goals are heavy and difficult to grip. Transporting the goals to the zones poses a challenge of its own as they are barricaded with thick bars.

The Setup

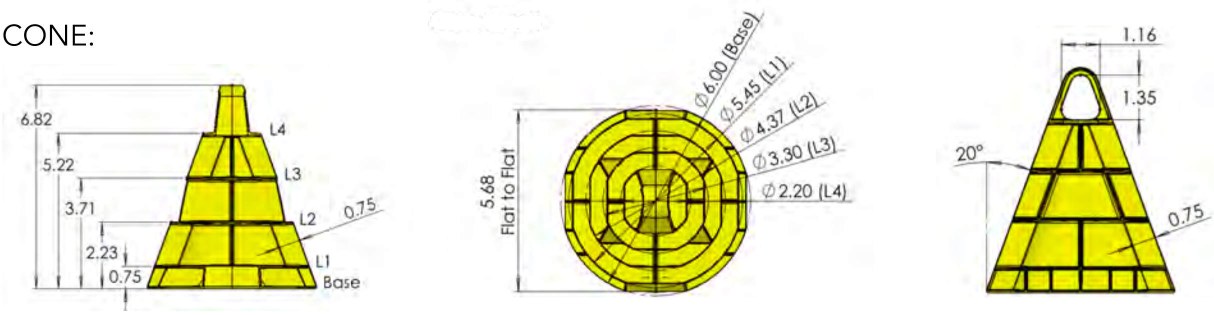
Each VEX Robotics Competition In the Zone Match includes the following:



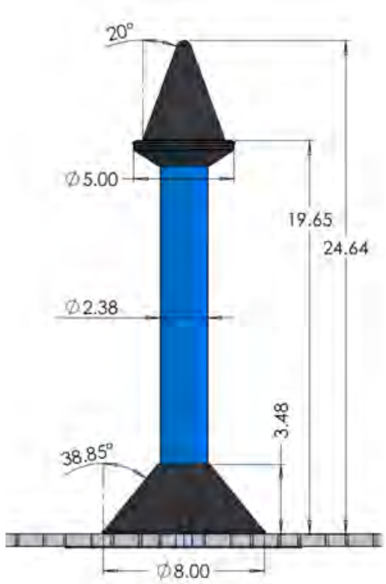
- 90 Scoring Objects
  - 80 Cones
    - 4 Cones, 1 per Robot, as preloads
    - 24 Cones, 12 per Alliance, as Match Loads (used for loader)
    - 52 start at designated locations on field
  - 8 Mobile Goals, 4 per Alliance
  - 2 Stationary Goals, 1 per Alliance
  - 6 Goal Zones (5, 10, & 20 pts), 3 per Alliance, for Scoring Goals
  - 4 Parking Tiles, 2 per Alliance, for Parking Robots

Game Pieces

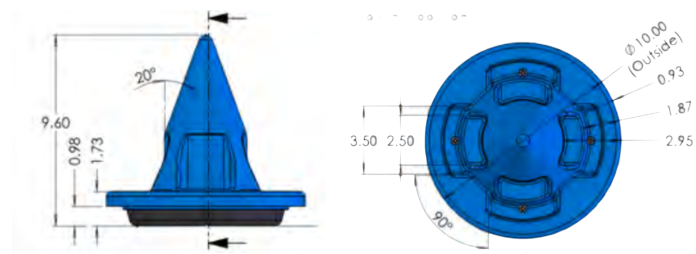
CONE:



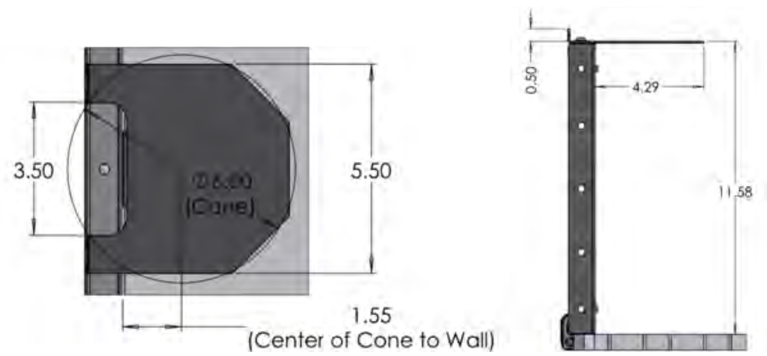
MOBILE GOAL:



STATIONARY GOAL:



LOADER:



Key Rules

- Game time: 15 second autonomous period with 1 minute 45 seconds of driver control
- A 10 pt bonus is added onto the alliance with the higher number of points during autonomous period
- Points could be scored by:
    - placing mobile goals into Goal Zones, receiving points for its respective values
    - each cone stacked on top of a mobile goal or a stationary goal is worth 2 pts
    - receiving highest stack on each scoring zone (20 pt, 10pt, 5pt and stationary), 5pts for each highest stack
    - parking robots at the end of the match for 2pts each
- The robot is only allowed to be possessing one cone at a time
- The robot must NOT be touching the mobile goal or the cone for it to count as valid pts

STRATEGY

Maximize Score

How do we maximize the score within “In The Zone”?

Through deciphering through the entire game manual, to watching “In The Zone” matches that have occurred through the summer months, the team came up with the top methods to achieving the highest score.

The easiest and the most number of points come from Mobile Goal Scoring, with a maximum potential of 50 points through that alone by placing one Mobile Goal into the 20 Point Zone and there into the 10 Point Zone.

The second simplest method of scoring is through obtaining “highest stack” in each of the scoring zones and the stationary goals. This gives a potential of 5 points in 4 distinct locations on the field, totalling up to 20 points.

The third identified key component in winning the match would be the 10 points won through the 15 second autonomous period. This 10 points can be seen as a determining factor between win or loss in many matches and is 10 points easily gathered with enough testing and preparation. In addition, the score points earned in autonomous is accumulative towards the entire game score, therefore it is only beneficial that the team is to be able to take full advantage of this period.

Lastly, we took note of the use of the Loader that is attached to the side of the walls. The Loader provides ease of stacking cones due to the fact that the robot can simply grab the cone from the same location every time, thus achieving very high efficiency throughout the game. Each Alliance is allowed 12 cones to be used through the Loader during each match, meaning taking full advantage of the Loader would provide 24 extra points. This would also aid in our previous strategy of achieving multiple “highest stacks”.

Our Goals

In this challenge, we have identified three areas that we hope to perfect.

1. Internal stacking — being able to transport and stack onto a mobile goal internally
2. Mobile goal transportation into the 20 point zone
3. Autonomous — having two flexible autonomous settings; one for mobile goals and one for stationary stacking

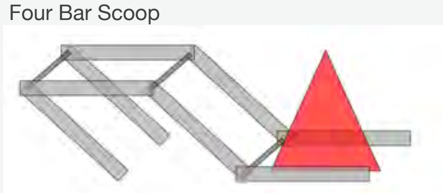
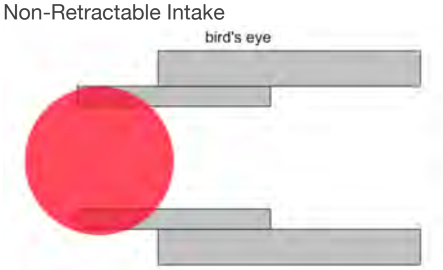
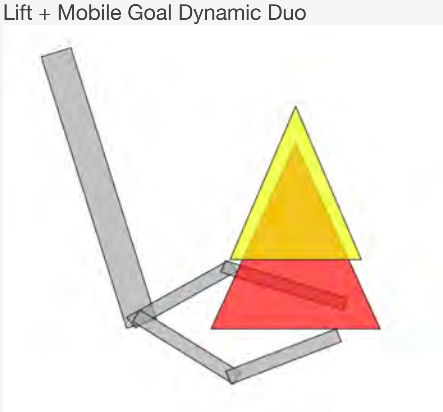
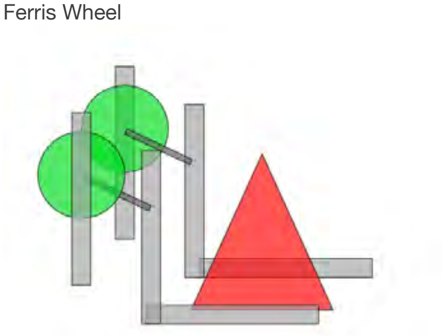
Goal 1: Internal Stacking
It is abundantly evident that driving, collecting cones, then driving back to stack onto a mobile goal is highly lacking in efficiency. Additionally, the rules state that the robot is only allowed to posses one cone at a time. To remedy this, having the mobile goal attached onto the robot allows for instantaneous stacking — the robot no longer needs to drive back and forth between collection and unloading without the violation of policy.

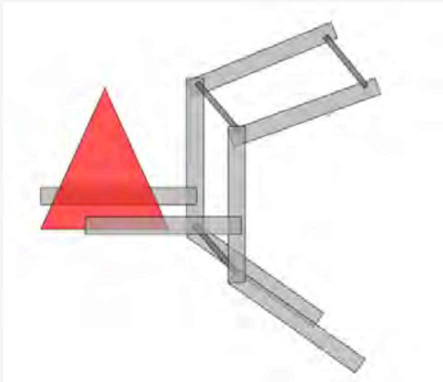
Goal 2: Mobile Goals in 20 Point Zones.
A major source of points is the 20 point zone. By simply placing a mobile goal in this sone, teams score 20 points. However this location is highly inaccessible, require the robot to overcome two physically demanding obstacles.

Goal 3: Flexible Autonomous
Winning the autonomous period. It is most optimal to have two different settings, just in case that our alliance has a colliding autonomous setting.

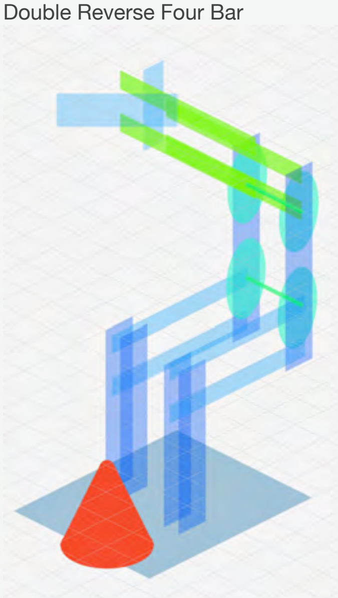
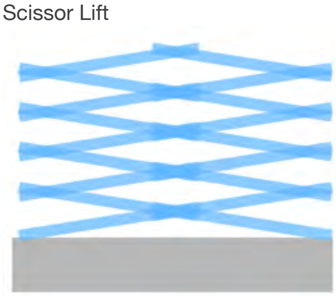
IDEATION

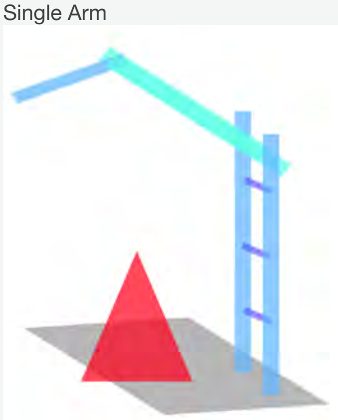
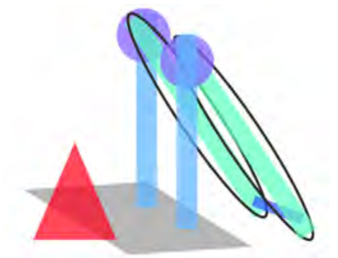
Mobile Goal Intake

		Pro	Con
01	Four Bar Scoop 	• Easy control • Simple	• Difficult to pick up • Inconsistant • Takes up a lot of space on the robot
02	Non-Retractable Intake 	• Doesn't need a motor to deploy • No extra step/control required. deploys when lift is lifted during autonomous	• Can't control deployment or retraction • Expensive • May need a motor on the head of the intake
03	Lift + Mobile Goal Dynamic Duo 	• Less controls to worry about	• Cannot do internal stacking • Might be difficult to find a good balance for something that can pick up both a Mobile Goal and a cone
04	Ferris Wheel 	• Small mechanism	• Slow • Could be very weak

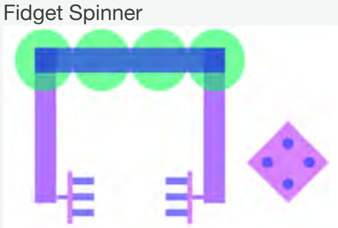
05	Passive, attached to lift 	• Saves space on the base of the robot	• Difficult to find a placement for the intake • Often found at the back on the robot

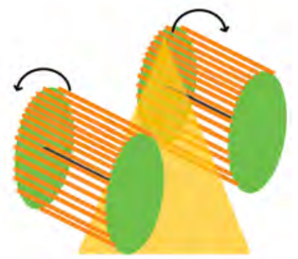
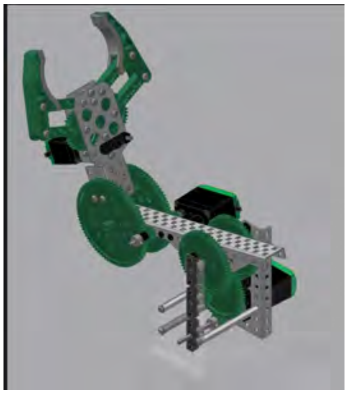
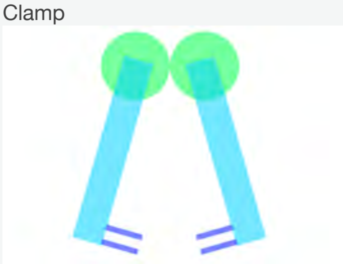
Lift Mechanism

		Pro	Con
01	Double Reverse Four Bar 	• Easy control • The front of the double reverse four bar will always be in the same x-axis position • Could be very tall, allows for a very large number within highest stack • Very optimal for the Loader	• Heavy, a lot of metal to lift a very light cone • Could have problems synchronizing the two sides • motors mayn't be strong enough
02	Scissor Lift 	• High extension • One control from extension	• A lot of metal, very heavy • Difficult to build

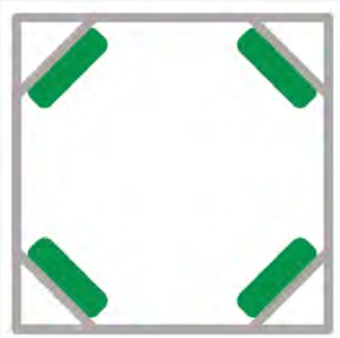
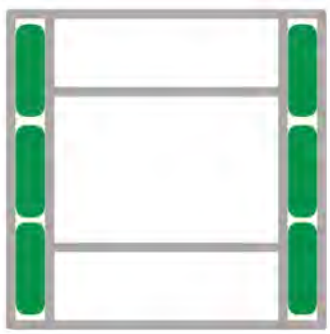
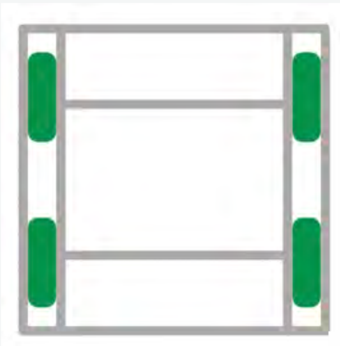
		Pro	Con
03	Single Arm 	• works like a physical human arm • a simple design	• unbalanced • may be difficult to attach a claw to be centered
04	Chain Bar 	• simple control • No need for further repositioning to land on the mobile goal if built correctly	• Limited in positioning • Limited in height
05	Dyson Lamp 	• Easy to implement and imagine	• Requires multiple linear gears • Could be slow in movement • Very restrictive, cannot extend far

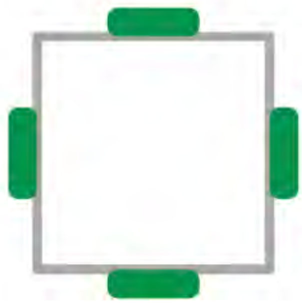
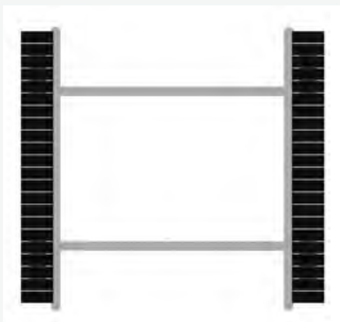
Claw

		Pro	Con
01	Fidget Spinner 	• Can pick up tilted cones	• needs a lot of space to work with to pick up a cone • small margin of error, more difficult to pick up a cone

02	Rolling Intake 	• Efficient in picking up the cones • large margin of error	• Cannot pick up fallen cones
03	Round Claw 	• Simplistic idea	• difficult to get the positioning right • difficult to install onto the robot • could be heavy
04	Clawbot Claw 	• Not much new building is required • Relatively reliable in ability to pick up cone	• Very small margin of error • only able to pick up cone from a certain location • zero innovation • cannot pick up fallen cones
05	Clamp 	• Light and simple • relatively secure	• the claw always needs to be below the arm, therefore the arm must be able to reach very high • cannot pick up tilted cones

DRIVE BASE

		Pro	Con
01	X-Drive 	• Highly maneuverable • Omni-directional wheels allow for multidirectional movement • Allows for strafing • Compact turning	• Takes up too much space internally leaving no space for mobile goal stacking • Hard to overcome 20 point zone obstacle
02	H-Drive with 6 wheels 	• Strong and fast, many motors • With omnidirectional wheels, high manoeuvrability is retained • Only takes up space on the two sides, clearing the central cavity for other uses. • Sturdy and reliable • no multidirectional movement	• Waste of limited motor numbers. We are only allowed to have a maximum of 12 • Fitting in all the motors leaves less space for support structures
03	H-Drive with 4 wheels 	• Simple and easy to implement • With omnidirectional wheels, high manoeuvrability is retained • Only takes up space on the two sides, clearing the central cavity for other uses. • Sturdy and reliable • no multidirectional movement	

04	Box Drive (4 wheels) 	• multidirectional movement with no compromise • Fast turning and high manoeuvrability	• blocks the front of the robot • does not allow for easy mobile goal intake • Hard to overcome 20 point zone obstacle
05	Tank Drive base 	• Really good at overcoming the 20 point zone obstacles • no multidirectional movement	• slightly slower due to added resistance and friction • Takes up a lot of space • difficult turning

CONCEPTUALIZATION

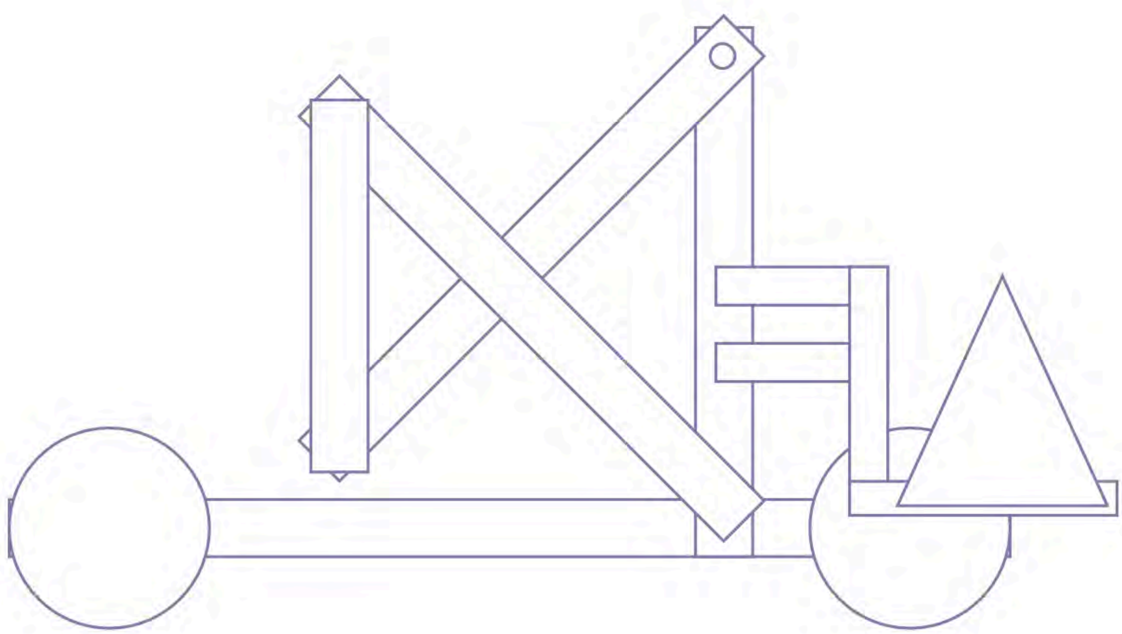
The Robot That We Want

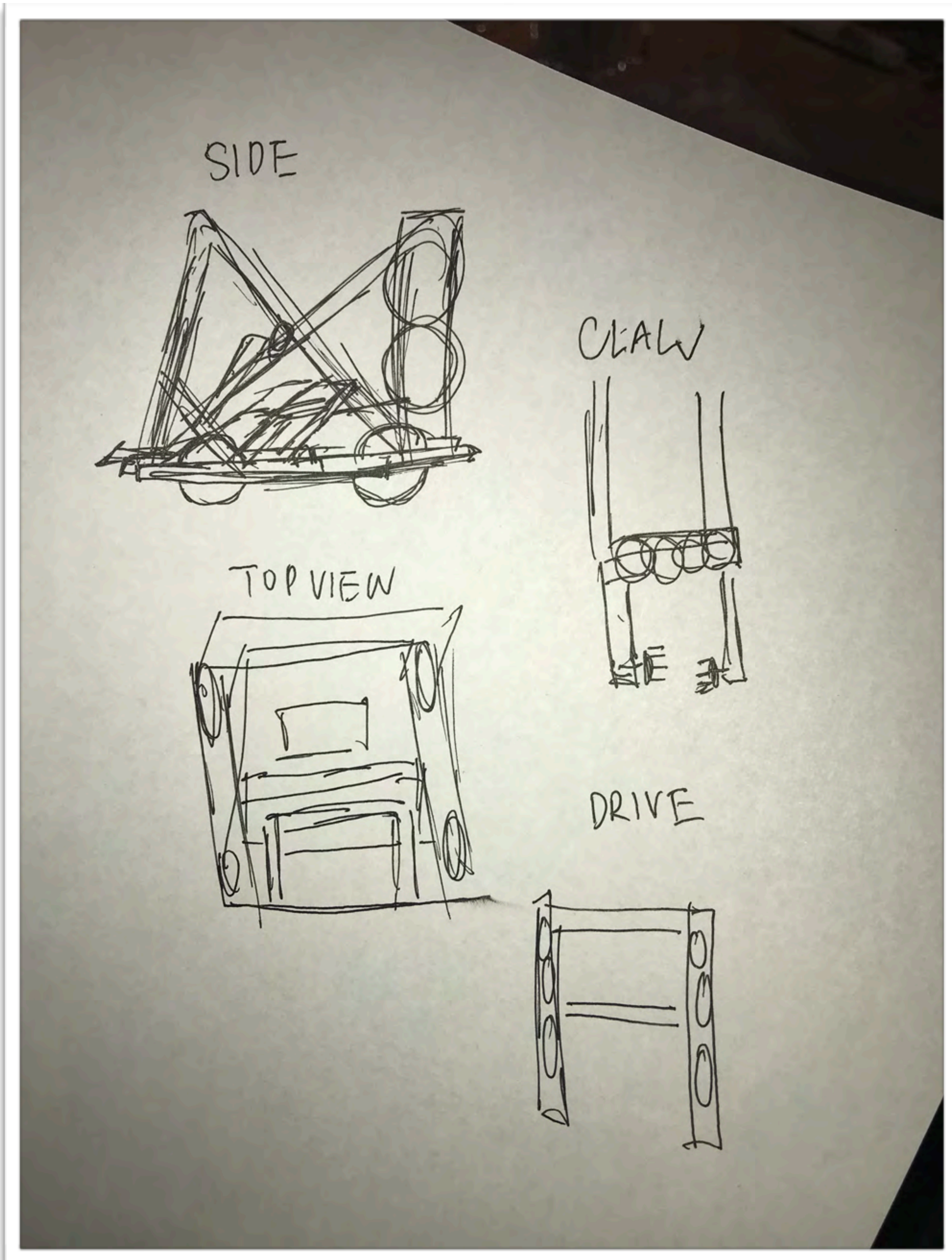
The robot that can best align with our goals is the double reverse four bar.

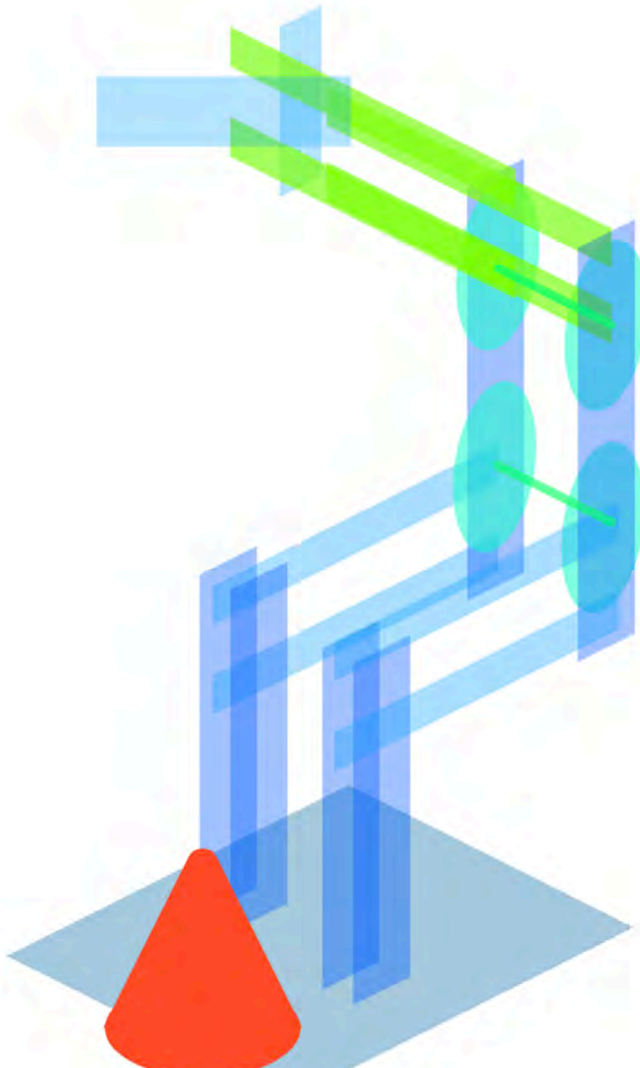
Allows us to do:
- High-stacking
- Internal Stacking
- Transport mobile goals
- get into the 20 point zone

- it is fast
- it appears reliable
- linear motion is relatively easier to control as well as program
- folds neatly and considers the size restrictions

After deciding on the double reverse four bar approach, we got to work.




SIDE
CLAW
TOP VIEW
DRIVE



TIMELINE

AUGUST 2017

S	M	T	W	T	F	S
		1	2	3	4	5 Began analysis of In the Zone
6	7 Devising strategy and planning for construction	8 Research	9 Research	10 Research	11 Consolidated possible designs for mechanisms based on research	12 Organized inventory and deicide on primary design prototype of robot
13	14 Finalize desired design and planned first order of parts	15	16	17	18	19 Began construction of base
20	21 Constructed frame; wheel and motor housing. Attached 6 wheels	22 Waiting for shipment of chain and sprocket system	23	24	25 **GOAL** — Complete Base Construction	26
27	28	29	30	31		

SEPTEMBER 2017

S	M	T	W	T	F	S
					1 Arrival of first shipment of parts	2
3 Added chain and sprocket onto base	4 Began work on lift	5	6	7	8 **GOAL** — Complete Lift Construction	9 First iteration of lift completed
10 Trouble shooting lift issues	11	12	13	14	15 Began Mobile Goal Construction	16
17	18	19 Modified Mobile Goal	20	21	22 **GOAL** - Complete Mobile Goal Lift Construction Began attaching	23 Continued to try and attached the three separate components of the robot
24	25 Finally attached the three components + Fidget spinner component created	26	27 Elbow and motor attached for claw	28	29 **GOAL** - Complete Claw Construction	30 Attached and wired robot components

OCTOBER 2017

S	M	T	W	T	F	S
1	2 Robot is programmed and tested	3	4 Lift reinforcements are added	5	6 troubleshooting issues with lift misalignment	7 Hypothesis created for why lift was misaligned Further research conducted
8	9 Disassembled right side of lift	10	11	12	13 Disassembled left side of lift	14
15 Reassembled left side of lift	16	17	18	19	20 Reassembled right side of lift	21
22	23 Rewired both sides of the lift and tested again Motors on lift still out of sync	24	25 Disassembled right and left sides of lift	26	27 Removed and altered gear ratios in lift and reassembled	28 Tried to sync lift motors programatically
29	30	31 Auto-drop function conceptualized and fleshed out				

NOVEMBER 2017

S	M	T	W	T	F	S
			1	2	3 **GOAL** — Complete all aspects of the robot (build and programming)	4
5	6 Issues with lift ensue	7	8	9	10 Added triangular elastic reinforcement on the lift in order to stabilize	11
12	13	14 Kept adding elastics and fixing the lift	15	16 3PM-3AM building. Fixed claw, kept trying to ameliorate lift	17 All-nighter to keep fixing the lift and program autonomous as well as auto-drop	18 **Brampton Robotics VRC Qualifying Event #1** ***➜ miserable results***
19 Reflected on competition Identified key faults with initial design	20	21	22 Brainstormed new designs for the next competition	23	24 Disassembled the entire robot except the base	25
26	27	28 Finalized new design for the December competition	29	30		

DECEMBER 2017

S	M	T	W	T	F	S
					1 Began construction of the new mobile goal intake	2
3	4 Completed new mobile goal intake	5	6	7	8 Worked on arm	9 Finished arm Added rubber bands to relieve stress on motors
10	11 Devised programming strategy for arm	12	13	14	15 Programmed robot	**16** **Mississauga VCR Qualifying Event** ***➜ Failed again***
17 Reflected on competition	18	19	20	21	22	23
24	25	26	27 Added motor and gear to strengthen shoulder	28	29	30
31						

JANUARY 2017

S	M	T	W	T	F	S
	1 Added additional motor to strengthen the elbow	2 Added shaft encoders for better auto	3 Brainstormed new claw ideas	4 Completed new claw and attached	5 Added a wrist component to the arm lift	6
7	8 Driver practiced	9 Changed into clawbot claw	10	11	12 Autonomous programmed	13 **Central Ontario VCR Qualifying Event** ➜ ***Ranked top 5 in qualifying***
14 Reflected on competition	15	16	17	18	19 Changed claw design to rolling intake	20
21	22	23	24	25	26	27
28	29 Completed rolling intake	30 Autonomous Coding	31 Autonomous coding			

FEBURARY 2017

S	M	T	W	T	F	S
				1 Worked on new autonomous Changed motors on base	2 Autonomous Robot stops working	3 **Brampton Robotics VCR Qualifying Event #2** ***➜ didn't compete well***
4 Reflected on competition + Improved wrist and intake	5	6	7	8 Programming	9 Programming	10 **iDesign Central Toronto VCR Qualifying Event**
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

ITERATIONS

AUGUST 2017

05 S First look at the game

Members Present:
- Watched the Introduction video
- Read the Game Manual
- Watched matches that have occurred throughout the summer
- Talked with a team in China on how they built their robot and drew some inspiration

07 M Strategizing

Members Present:
- Discussed potential strategies and how to implement them
  - Made notes on valuable functions such as internal stacking
  - Decided that our robot would need to be able to high-stack, internal-stack, and transport mobile goals into the 20 point zone.
- Began researching how other teams have tackled these challenges

08 | 10 T-T Individual Research

Members Present: ALL
- Double reverse four-bar seemed to be the best, most successful design
- Watched a lot of Youtube videos of competitions that occurred in Asia, especially in China
- All members were to bring back ideas of what they thought would be the best approach

11 F Consolidated Design Options

Members Present:
- Made a full list of all the possible designs for the Mobile Goal Lift, Arm Lift, Claw, and Drive Base
- Drew out disarms on Affinity Designer for each design idea (please view IDEATION for the full list of creations as well as diagrams for each one)
- Listed possible Pros and Cons for each possibility

12 S Began Design Process

Members Present: Alexis, Jake, Anton, Jonathan Hai

- Took inventory of all our available parts to see what we have available to use:

GEAR			**ALUMINUM BARS**	
Standard Strength: 84 tooth: 16 60 tooth: 23 36 tooth: 7 + 2 sanded to slip gears 12 tooth: 18	High strength: 84 tooth: 12 60 tooth: 1 36 tooth: 9 12 tooth metal pinions: 30	Rack gears: 4	1*2*1 c-channel: 4*25, 1*21, 1*20, 2*6, 6*5 1*3*1 c-channel: 3*35, 2*30, 4*10, 2*8, 1*7, 1*6, 4*5 1*5*1 c-channel: 4*34, 1*30, 1*26, 6*25, 2*15, 3*10, 2*6, 4*5 2*2 angle: 2*5	
HIGH STRENGTH SPROCKETS & CHAIN		**WHEELS**	**STEEL BARS**	
Sprockets: 30 tooth: 4 24 tooth: 4 18 tooth: 4 12 tooth: 2 6 tooth: 6	Chains: Chain: 106 Chain attachment links: 40	4" Wheel: 16 4" omni wheel: 9 2.74" omniwheel: 4	1*2*1 c-channel: 2*30, 2*20, 5*15, 4* 10, 2*7, 2*5 1*3*1 c-channel: 0 1*5*1 c-channel: 3*25 2*2 angle: 2*35, 9*20, 2*10 5* Plate: 2*26, 1*15, 1*10, 2*5 Bar (1*25): 8 Chassis Rails 2*1: 2*25, 17*16 Chassis Bumper 2*2*15: 2	
MOTORS				
2 wire motor 393: 22 good, 1 with integrated shaft encoder, 2 broken but fixable Clutch: 3	Motor gears : Torque compound: 23 Torque single: 23 High Speed compound: 27 High Speed single: 27 Turbo compound: 2 Turbo Single: Top flat gear: 8 short + 2 long shaft encoder module: 2		Turbo Single: Top flat gear: 8 short + 2 long shaft encoder module: 2	
SHAFTS & HARDWARE				
Shaft: 2" shaft: 3 3" shaft: 19 12"shaft: 2 Odd lengths: 11 (1,2), 3 (2,3), 2 (3,12)	Shaft Hardware: Shaft coupler set: Coupler: 34s Shaft: 34 Shaft collars: 28 8-32 * 0.125" setscrew: 3	Spacers: 4.6mm plastic spacer: 57 8mm plastic spacer: 23 1/8" nylon spacer: 1 3/8" nylon spacer: 2 1/2" nylon spacer: 8 Steel washers: Approx. 400		

- Began the *Conceptualization* portion of the Design notebook, coming up with how we want our overall robot to appear

14 M Finalized Robot Design

Members Present:

- Completed the *Conceptualization* portion of the Design notebook
- Decided that in order to be extremely competitive during the competition, a double reverse four bar would make us the strongest
- As for the claw, we want to go with the fidget spinner design as we felt that it was essential for the robot to be able to pick up cones that have fallen over
- We are to use a four bar for our Mobile Goal intake as we found the design to appear the most reliable and simple to imagine
- As for the Drive Base, we decided on a 6-wheel drive as we believe that we have enough motors available to run the double reverse four bar, as well we would like to increase the speed and strength of our base
- View CONCEPTUALIZATION for full robot

19 S Began Construction of Base

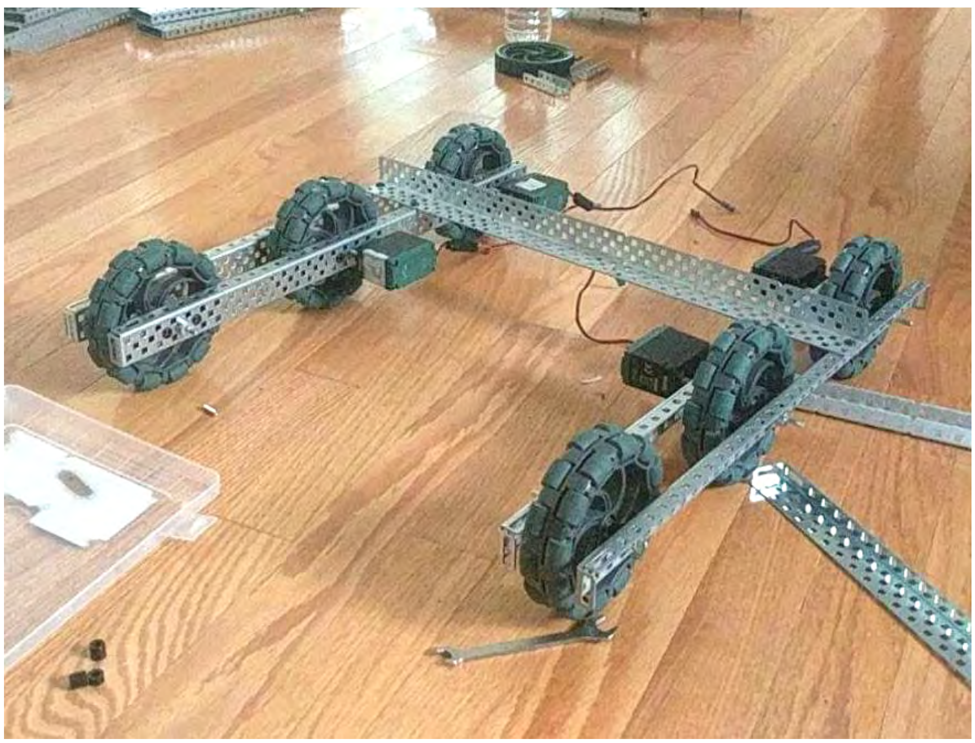
Members Present: Anton

- Set goals/deadlines to help us stay on a build schedule
    - [ ] Complete Base by Aug 25th
    - [ ] Finish Lift by September 5th
    - [ ] Complete Mobile Goal Lift by September 22nd
    - [ ] Build the Claw by September 29th
    - [ ] Be ready for our first competition two weeks ahead of time to allow for enough time to practise driver control
- After deciding on the six wheel drive, we got to work
- It took us a while to decide on how to position the wheels because we had to plan where everything else would go
- We decided on using omni-directional wheels due to the flexibility and maneuverability that it brought our team in our competitive last year and thus, believes that it would aid in our rotations this year as well
- Made sure the wheels would not obstruct any other components

21 M Constructed Frame, Attached Wheels

Members Present: Anton

- Built the frame for holding the wheels and applied the wheels
- Steel bars were used as the frame rather than aluminum because we wanted a base heavy robot that would be very stable. As the rest of the robot could be very heavy, we wanted to make sure that there would be zero chance of collapse
- Attached the motors, each directly onto a wheel
- Successfully finished the base of the robot (minus chain and sprocket)
- Length: 35 holes long,
- Width: 35 holes long
- We have pretty much almost maximized the size limit for the base



☑ **Completed Before Goal**

22 T Placed Order For First Shipment of New Parts

Members Present:

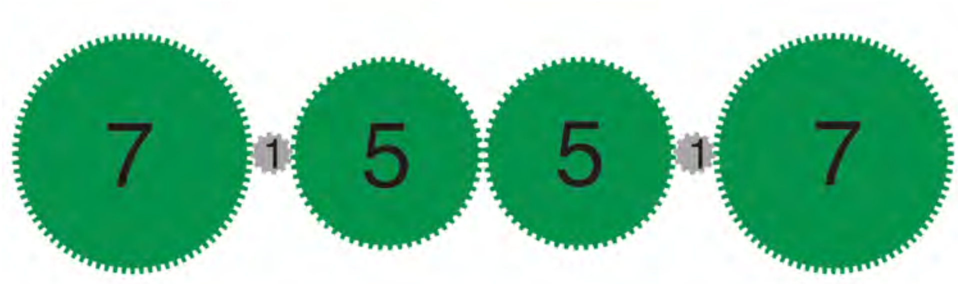
- Budgeted and calculated everything that we would need in order to create our brand new robot
- Ordered: Chain and Sprocket set, 3*35*1 aluminum bars, 2 packs of shaft collars, large and small black spacers, new motors

SEPTEMBER 2017

3 S Received Shipment of New Parts

- Added the chain and sprocket system to the base
- Using 4 motors to power 6 wheels rather than 6 motors

4 M Began Work on Lift



Members Present:

- Reviewed blueprints made for the lift
- decided on how to attach the lift to the base
- Selected the gears to be used — 7:1:5 ratio
- 2 motors on each side on the four bar
- Measured out length of aluminum bars used
- Began assembly of one side of the four-bar

9 S First Iteration of Lift Completed

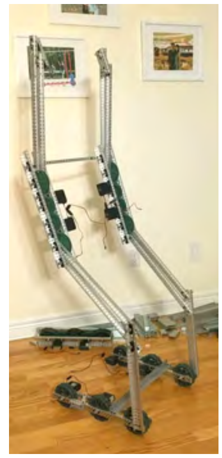
Members Present:

- continued and completed the lift
- Attached lift to base

× Found issue with placement of wheels — there isn't enough power to support three wheels on each side. Additionally we realized that we would not have enough motors later down the road. Having 3 wheels on each side also limits the space that we have available in order to attach the upper portion of the robot, thus stabilizing it.

10 S

Troubleshooted Lift



Members Present:

- Evaluated how well the lift works with the current drive base
- Found that the single bar support attached to the drive is NOT enough to support the weight of the heavy lift, thus a second side is added to the very bottom part of the lift

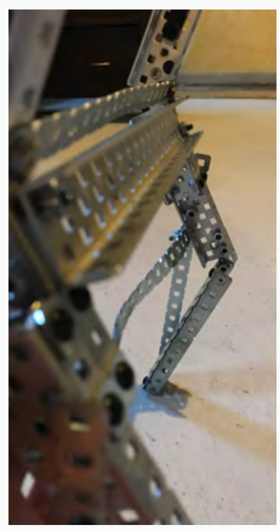
× After attaching, we found the lift to be extremely wobbly and unstable

15 F

Begin Mobile Goal Intake

Members Present:

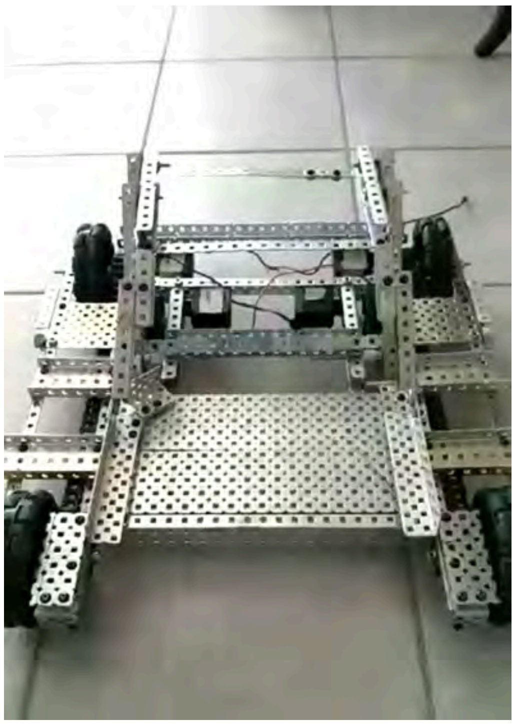
- Took out the 8 15*2 aluminum bars required for the intake
- Attached and screwed together necessary components to create the basic idea of the four bar
- Used the available Mobile Goal as measurement for width of the mobile goal, we are using 20 holes as the width



19 T Completing Mobile Goal Intake

Members Present:

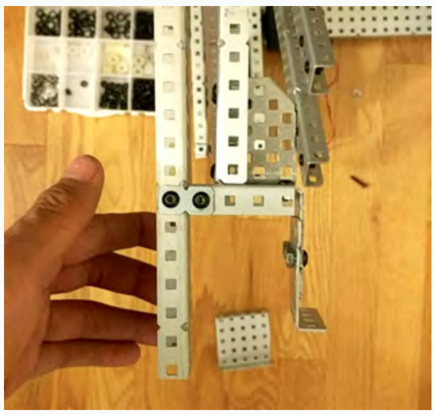
- ✦ Changed the c-channel used for the front part of the lift into L-channels
- ✦ Added a diagonal support behind the L-channels to better stabilize the Mobile Goal when put on
- Added thin flat one hole width bars to act as support to keep the shape of the mobile goal lift

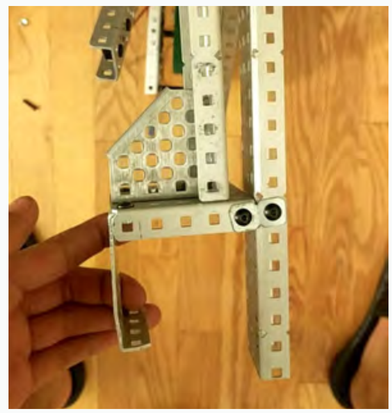


22 F Beginning to put together the robot

Members Present:

- Many modifications must be made in order to successfully piece together the robot
- ✦ With so many wheels on the drive, it is impossible to attach the mobile goal lift onto it, therefore we must remove the middle wheels to make room
- ✦ Further strengthening of the interconnection between the lift and the base was added
- ✦ We realized that when the lift comes down, it is positioned terribly, hitting the wheels every time, thus the wheels MUST be protected. A small platform was built for the lift to rest on

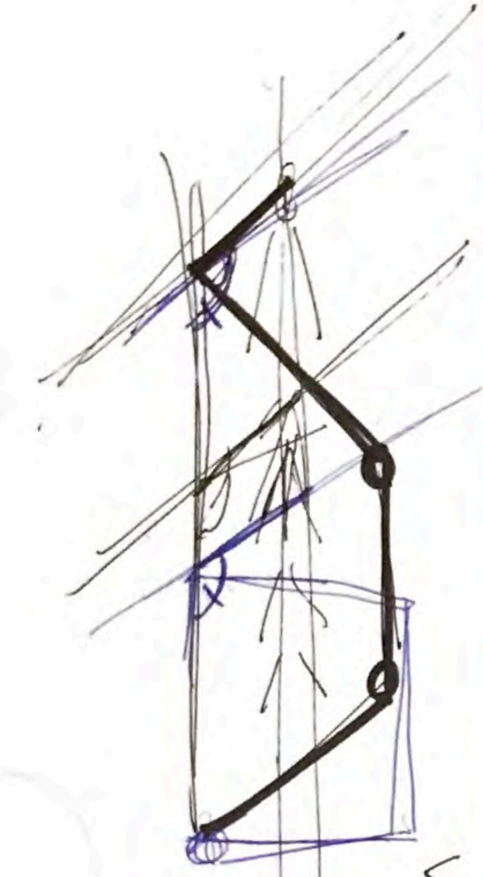




23 S Making more Iterations

Members Present:

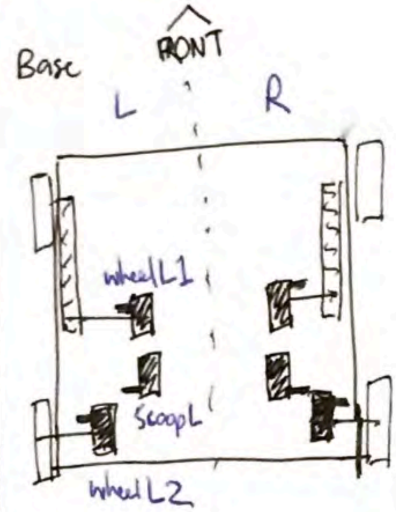
- Continuing where we left off yesterday
- Making all the components all fit together in the final assembly proved harder than initially planned
- Some motors had to be shifted to make room for the additional motors of the mobile goal intake.
- The lift is successfully attached to the base, however major sagging inwards continued. Standoffs were forcefully attached to form trusses, allowing the heavy columns of the four bar to stand better
- All the supports had to be carefully considered as they could not take up any space allocated to the mobile goal intake
- ✦ The base itself was reinforced with additional horizontal c-channels



Blue = smaller height of stack

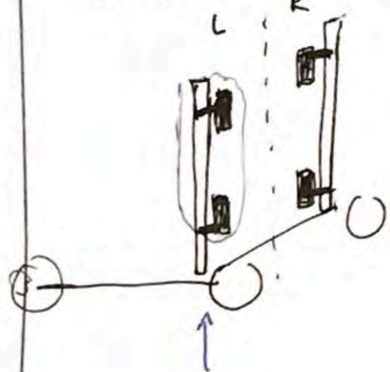
MOTORS

Base



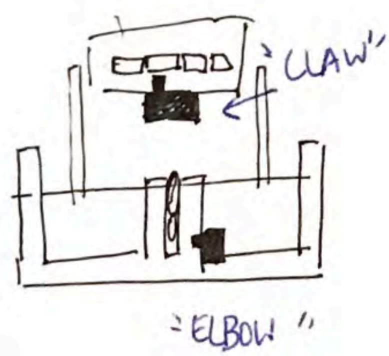
wheelL1 = wheelL2

wheelL

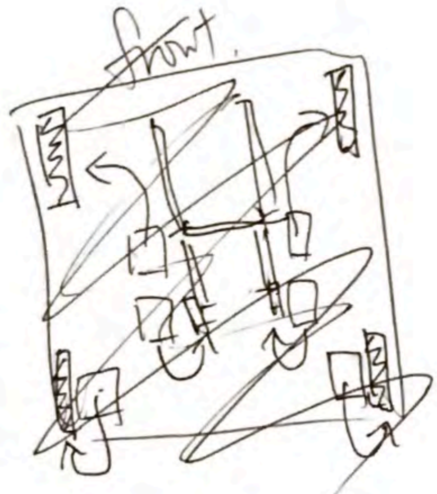


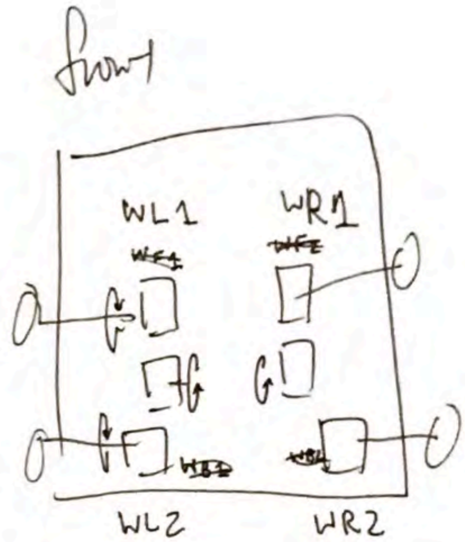
liftL1

liftL2



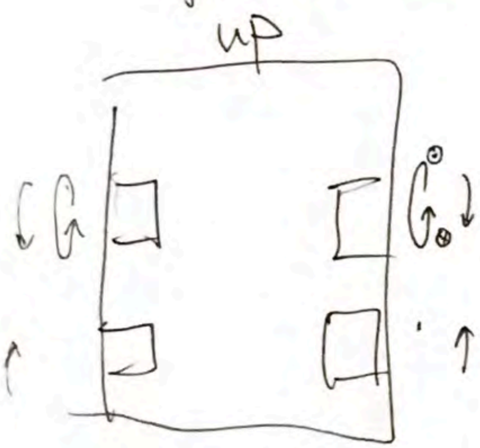
Base

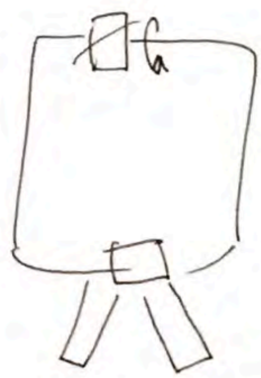




WL1 = WL2 WR1 = WR2
↳ WL ↳ WR

lift. (front view)



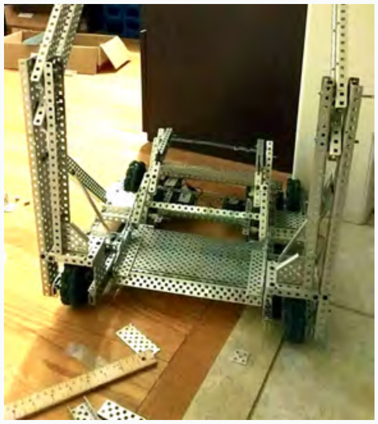


25 M

Completed Assembly of Major Components

Members Present:

- Robot is now whole, entire body assembled



- Tested our “Fidget Spinner” claw design, that allowed the cones to spin freely and be pulled down by gravity when gripped — this meant that an additional motor was not needed to rotate the cones to a desired position.

- 100 shaft collar milestone reached

27 W

- The elbow and motor was attached to the claw
- The entire mechanism for grabbing cones was attached to the four bar lift

☑ **Completed Before Goal**

30 S Wiring

- Made sure all the attachments were secure and roughly finalized
- Wired the many motors and components to the cortex attached to the base.
- Required extensive use of zip-ties
- Made sure the wires still allowed for the robot to move freely through the use of extension cables

OCTOBER 2017

2 M Programming and Testing

- Created extensive diagrams on the positioning of motors and which ones had to be reversed programatically
- Devised naming conventions to be used for consistency
- Created joystick controls for intuitive use of robot (and conservation of a joystick on the controller)
- Check next page for diagrams
- Noted that Y-cables had to be utilized for drive due to lack of cortex ports
- Ran the code and tested the robot for the very first time

× The robot has a terrible tendency to sag to one side. The four bars lacked synchronization and overall build quality was lacking and saggy.

```
void findAngle(float x, float y){
    //if the x is + and y is + then just use angle as it is

    //calculates the related acute angle
    float angle = atan(y/x) * 180.0 / PI;


    if (x == 0 && y == 127){
        angle = 90
    } else if (x == -127 && y == 0){
        angle = 180
    } else if (x == 0 && y == -127){
        angle = 270
    } else if (x == 0 && y == 0){
        angle = 0
    } else {
        //determines the actual angle in terms of 360 degrees
        if (x < 0 && y > 0){
            // Q2
            angle = 180 + angle;

        } else if (x < 0 && y < 0){
            // Q3
            angle = 270 + angle;

        } else if (x > 0 && y < 0){
            //Q4
            angle = 360 + angle;
        }
    }
    return angle;
}
```

//This is how we created the joystick controls. Using some trigonometry we could calculate the direction of the joystick and thus instruct the robot where to move.

However, the code was rendered useless when the driver informed us he preferred tank controls. Baffling.

6 | 7 F-S

Troubleshooting Lift Sagging

- Due to severe misalignment, many possible reasons were considered:

1. the lift had insufficient power
2. the motors on the lift were not strong enough to support the weight
3. the motors on the lift were not spinning at the same rate
4. there were too many motors causing conflicts with each other

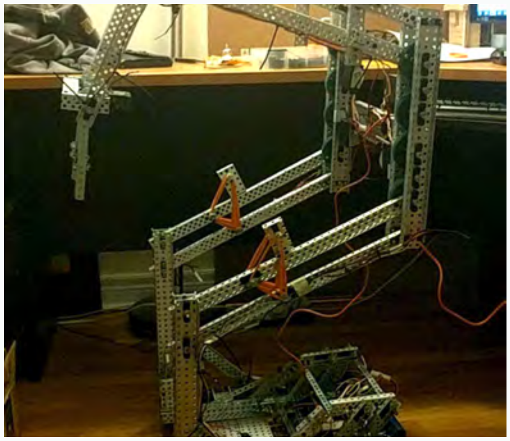
- 1: Power Expander added to lift to provide more power ➜ no change
- 3: nothing could be done to change the fact that the motors were not spinning at the same rate at the time being

- Further research was conducted, successful robots were carefully dissected to see how their designs allowed them succeed.
  - It was observed that triangular elastic supports aided the motors in allowing the lift to spring up
  - Also observed that our gear ratios were not ideal
  - Syncing motors could be done programatically via motor-encoders
-

9 | 20

Deconstruction and Reconstruction

- The first thing we altered was removing one set of motors from the lift. Though this helped slightly with the synchronicity of the two sides of the four bar, the lift was now severely under-powered. The two motors simply did not offer enough strength to support the weight of the lift
- Taking apart the main lift took multiple days as merely detaching and reattaching one side of the lift would take us 5 hours in time
- Thus, adding the triangle elastic supports was the next course of action. In doing so, we hoped that the elastics would pull the lift up. This would take strain off the motors. Although the elastic made raising the robot easier, they did not ultimately solve the issue of sagging.
- At times the elastic bands were actually found to be more difficult to use as the same number of elastic bands did NOT provide the same amount of power on both sides of the robot regardless of the fact that we put the SAME number of rubber bands on each side



- We decided that perhaps our build quality was to blame for all of these issues. We decided that rebuilding the lift with tighter attention to details could mitigate the effects of the sagging.
- This happened over the course of several days as disassembly was a very difficult and tedious process. An entire two weeks were spent doing this

23 M

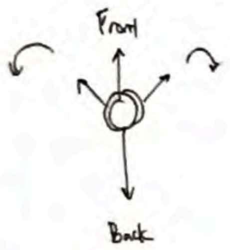
Rewiring and Testing

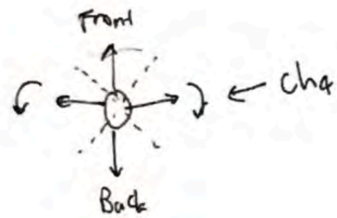
- With the two sides of the lift now fully rebuilt with the higher standard of quality, all the motors disconnected in the process now had to be rewired.
- The triangle elastic supports were rebuilt as well
- Upon rewiring, to our great disappointment, the lift **still leaned towards one side.**
- It felt almost hopeless at this point. We did not know how to proceed.

Functions

DRIVE

- ~~Left wheels forward / Right~~
  ~~Left wheels Backwards / Right~~





- move forward
- move backward
- Turn left
- Turn right

SCOOP

- Scoop Deploy ← move lift up if not already up
- Scoop Retract

Front facing up/Down

LIFT

Lift Raise
Lift Lower

ARM

- ARM EXTEND
- ARM RETRACT
- open Claw
- Close Claw

Auto Drop

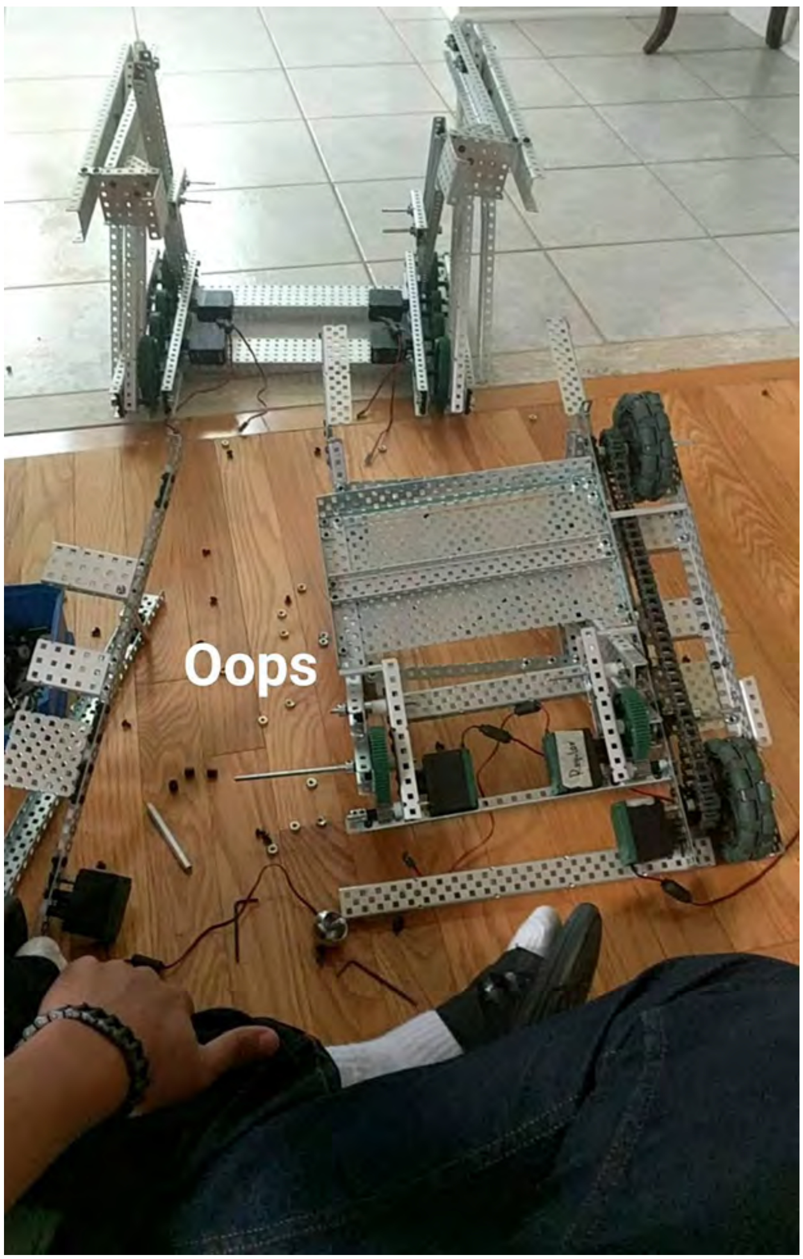
↳ keep track of # of cones stacked
  ↳ adjust automation based on height
  ↳ button(s) to keep track of height
* maybe second controller

calibrate by turning by Servo rotations and we manually measure dropping height.
↳ How much rotation yields how much height increase

25 | 27 W

New Gear Ratio

- We decided to try one more alteration, switching the gear ratio inside the lift to mimic another team we found online
- The new ratio was 1:5
- We also wanted to widen the amount of spacing that we had between the two bars of our lift as we thought that that might be the issue which prevents us from moving forward
- The originally spacing was 6 hols apart, the new plan is 9 holes apart on each side
- Of course this mean taking apart the lift **again**



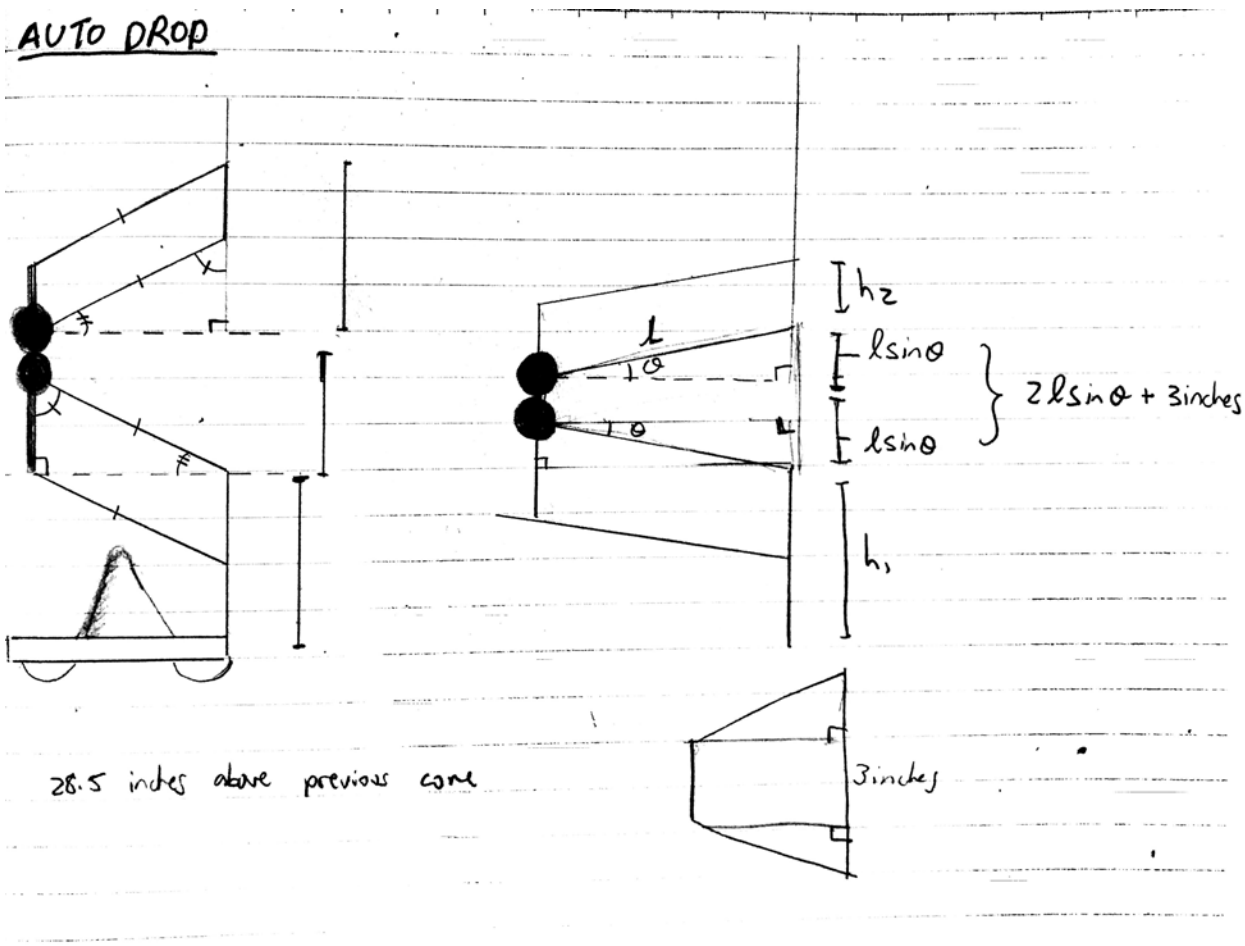
28 S Possible Solution Through Code

- Because all of our hardware attempts at solve the problem failed, our programmers decided that perhaps programming could solve the issues
- The motors might not be receiving the same amount of power. The could be determined via the motor-encoders.
- The motor encoders could also tell us how much the motor is rotating
- Given these two pieces of information, we could digitally see if the motors were behaving differently
- We tried to force both the motors to move in the exact same way
- If one motor had more counts than the other, wait until the other motor caught up before continuing to rotate.

Due to the unreliable nature of built in motor encoders, the solution also fell short. We later found that the motor encoders would frequently generate too much static electricity and short-circuit from a more experienced team.

31 T Autodrop()

- Despite all of our failures, our robot was still able to perform its basic function of picking up and stacking cones.
- Although the sagging was a major detriment we moved on to another problem
- Stacking cones was still a slow and difficult process for our human driver
- We devised a method of automatically stacking the cones onto the mobile with the press of a button
- The program would calculate intelligently how much to move and from what height to drop the cones from.
- Lots of planning was done as seen below



//We used the motor encoders to give us how many “counts” or rotation happened. Using this number, we converted to degrees of movement, giving us the approximate height of the robot at any given moment. In reality this did not work as mentioned previously, we did not know how motor encoders just fail and are extremely unreliable.

NOVEMBER 2017

03 F — Goal Date — To complete everything

A REFLECTION

- ☒ We unfortunately were unable to meet our goal to complete all programming as well as building
- ☒ We ran into many many problems
- ☒ The mobile goal lift is the only aspect of the robot that works
- ☒ We have not yet began our autonomous coding, nor the code that we wanted to write for our Autodrop function
- ☒ Our new goal is to complete everything by next Friday, the 10th in order to allow time for our driver to practise

06 M — More Programming and Testing

- Created extensive diagrams on the different possibilities
- We considered the fact that perhaps the arm lift was not getting enough support, therefore we added a parallelogram that is right next to the arm lift in order to help support

10 F — Improved Triangle

- The power of triangles really come to help us in our adventure
- We used standoffs with a shaft collar at the end to secure the elastics
- The new triangle that has been created is a lot further apart on the robot than prior.
- Due to insufficient power and a lack of time, we have to count on these rubber bands to get us through
- We put approximately 15 rubber bands on each side in order to somewhat power our robot, to allow it to move up and down

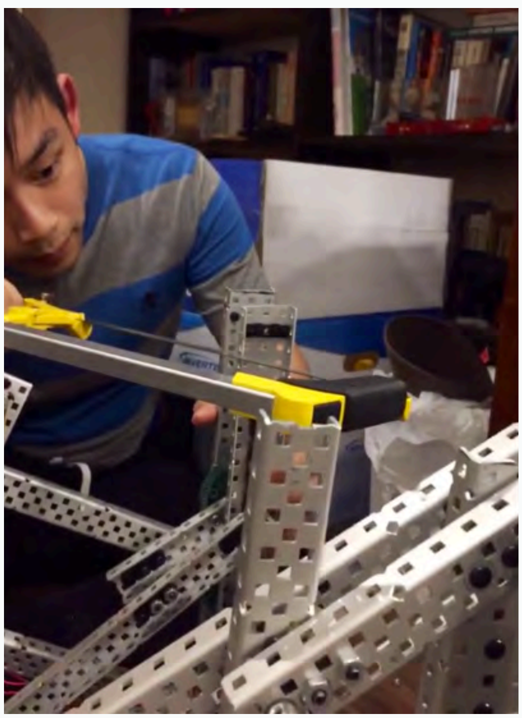
14 T — MORE ELASTICS

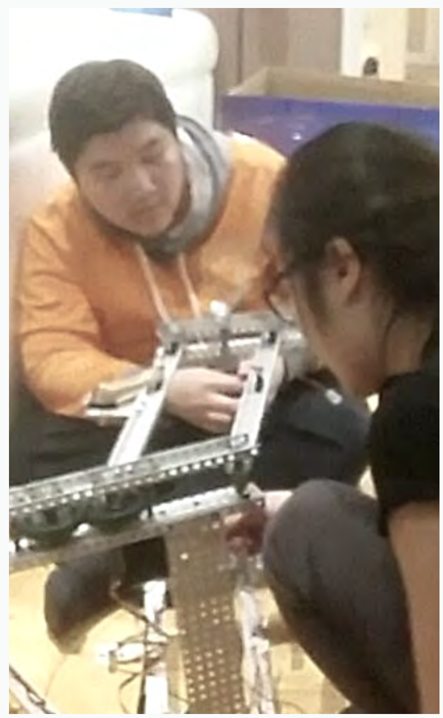
- It always seems like what we had was not good enough, it did not power the robot like how we wanted it to
- We adjusted the number of rubber bands that we had to use through tightening of other aspects of the robot

16 T All Nighter #1

Members Present: Alexis, Joey, Jonathan Y

- After finally kind of getting the lift to work, we began to truly test the workability of the robot as a whole
- We found more problems with the claw, it was not opening evenly, nor was its current position optimal to grab a cone, thus we had to shift the location of the shaft used to hold the fight spinner design
- The motor of the claw had to be detached and reattached because the gear ratios were not working out properly
- The entire lift was once again disassembled for small adjustments that further stabilized the robot (Adding more triangles to support)
- lots of cutting happened, Shafts were too long, the aluminum bars were too long, everything was just too long and had to be trimmed down and sawed in order to fix into the required dimensions

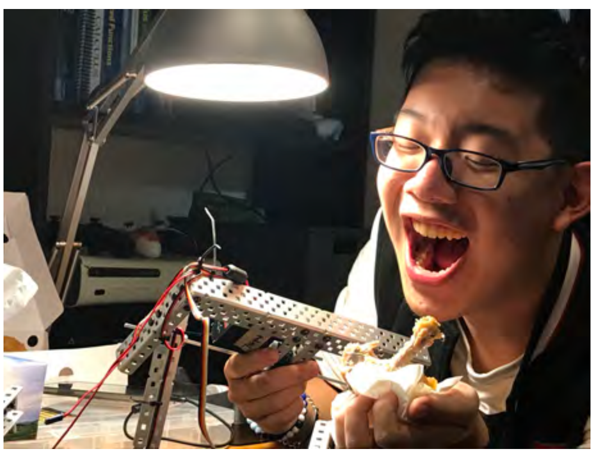




17 F All Nighter #2

Members Present: Jonathan H, Anton L, Alexis, Jake, Andy, Jonathan Y

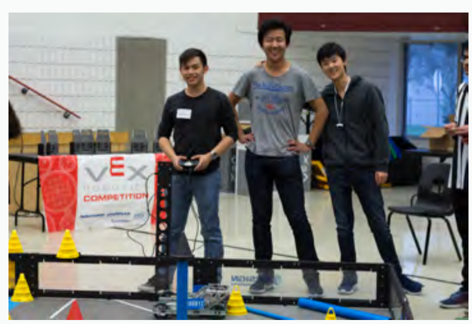
- The main goal for this night is to complete the coding the both auto drop AND autonomous period
- As well we had to make sure that the lift would work properly enough that it would be able to lift itself as well as the cones
- Joey kept trying to complete the autonomous code, but for reason reason, the code would not run the same every single time
- Jake kept writing the code for the Autodrop function, he used many trigonometry calculations that were correct logically, but for some reason did not run when testing
- Much frustration was present during this period of time
- Jonathan practised being able to stack cones
- We can stack at least 3 cones onto the mobile goal as of now when doing internal stacking
- Autodrop was NOT complete
- Autonomous was NOT complete



18 S

Competition Day

- We were constantly called the “Leaning Tower of Piza”
- We placed 13th our of around 30 teams
- We actually got to be one of the Alliance Captains, picking our own teams for the play-off qualification matches



19 S Reflection #1

What we did well on:

- Our base was really good and we were able to score in the 10 point zone quite consistently
- The mobile goal lift worked most of the time
- We learned a lot from other teams with similar designs during the whole process
- We got to pick alliances for the first time in the short history of our club!

What did not go so well:

- Our robot was given the nickname “leaning tower of Pisa” due to its unfortunate lack of posture
- The lift got jammed for 3 matches and as a result, the mobile goal intake could not be deployed. Our least reliable component hindered our most reliable component
- We lacked an ability to stack onto the stationary goal
- We had no autonomous
- For quarter finals, we completely removed our lift to focus exclusively mobile goals in the various scoring zones

What we learned:

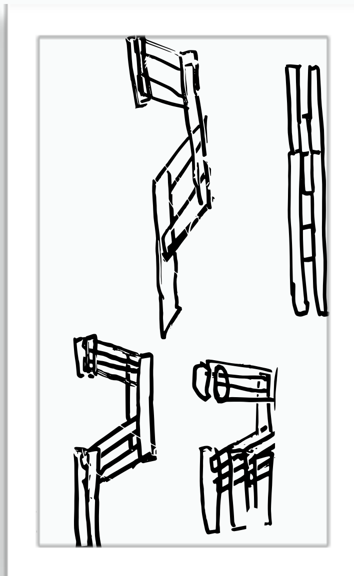
- MOBILE GOALS ARE THE KEY SCORING COMPONENTS
    - We were only able to place decently during the competition due to our mobile goal intake
- Many teams actually have been successful with a much less complicated design as opposed to a double reverse four bar. Actually, less than half the teams that advanced into the finals were NOT double reverse

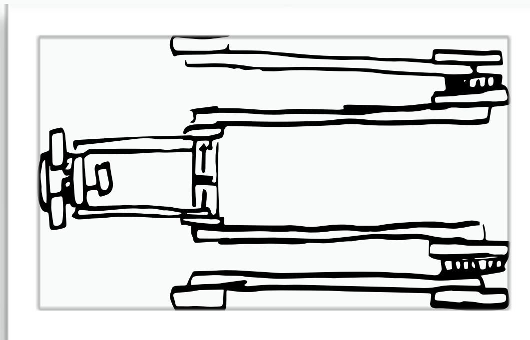
Our goals for the next competition:

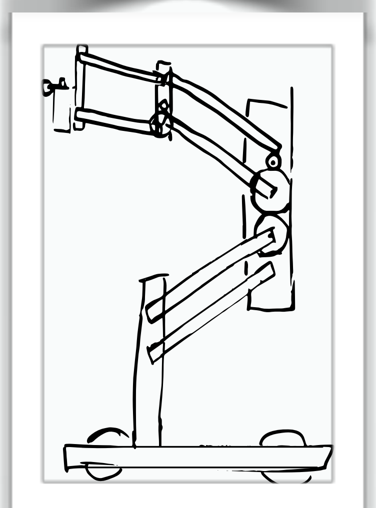
- We decided that our lift had to change in one of the following ways:
    1. Fix the sagging double reverse four bar
    2. Use a different method to stack (and internal stack) the cones
    3. Be more flexible, being able to stack not only within ourselves, but also on external components such as stacking on the stationary
- Although our mobile goal lift was our strongest component, it was still lacking in a variety of way and was quite inconsistent throughout the competition yesterday. We would like to build a better Mobile Goal lift that would be able to lift high enough to cross into the 20 point zone to score Mobile Goals
- Perhaps change the claw, the gravity component of the design was not used often as people did not go out of their way to tilt over the cones

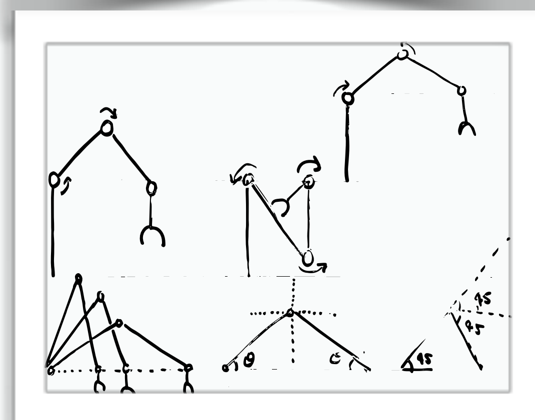
22 T Brainstormed New Design

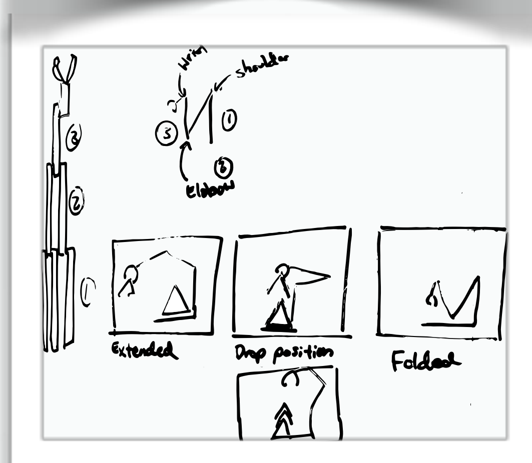
- In order to fit into our goals for the last competition, we decided brainstorm a variety of possible designs for our lift





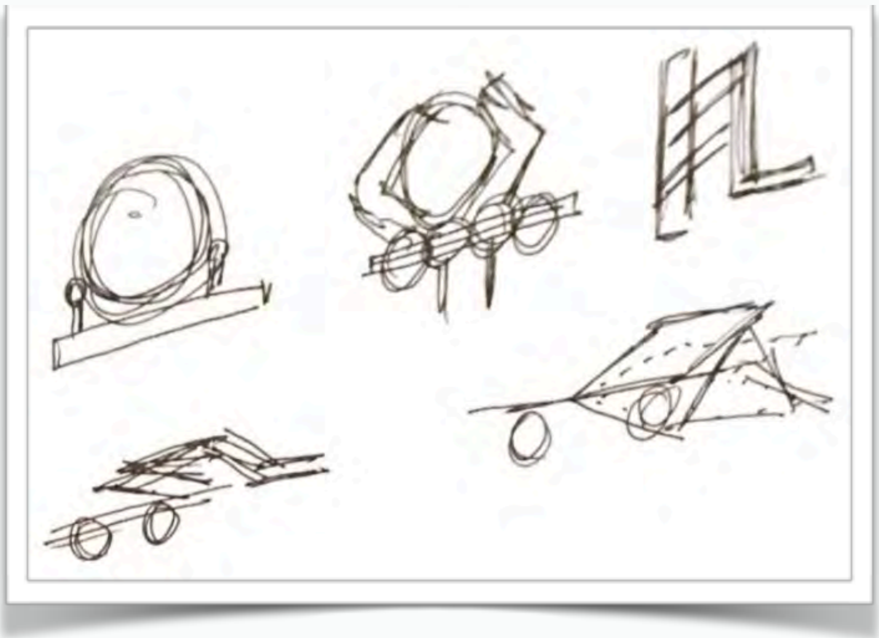






- A better Double Reverse Four Bar
- A single arm lift
- Going back to everything else we had on our ideation list

- We also considered a variety of ideas for the Mobile Goal intake
- We wanted something that would:
  - Take up far less room within our robot, leaving less empty space in the middle
  - Be a little more reliable in terms of picking up cones
  - Be able to reach.lift high enough for the 20 point zone



24 F The Ultimate Disassembling

- After deciding for sure that we will NOT be reusing our old design due its multiple fault areas, we have disassembled our months after months of hard work and dedication.
- The drive base was kept
- When disassembling, we found out how incredibly loose all the screws were on our robot as we had absolutely no time to tight it any further during our competition and we did not use any of the nylon screws

28 T Finalizing New Design #2

- In the end, we decided upon the single arm lift design for a multitude of reasons
  - Easy to visualize
  - Simple to make
  - Less joints (one sided vs two sided), therefore less controls to worry about and less motors can be uses/motors can be used elsewhere for effectively
  - We would have only 2 joins, a shoulder and an elbow
  - We did not want to add a wrist as we felt that it would be too heavy for the robot
- We decided on leaving the claw with a fight spinner idea, but much more simplified
  - We could not think of another option as using a single arm lift would absolutely require a gravity based claw without a wrist component
  - Our gravity based system worked quite well during that last competition

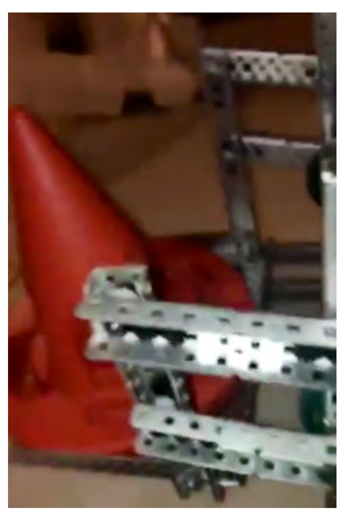
DECEMBER 2017

01 F Begin Construction of New Design

- First we started with the mobile goal lift

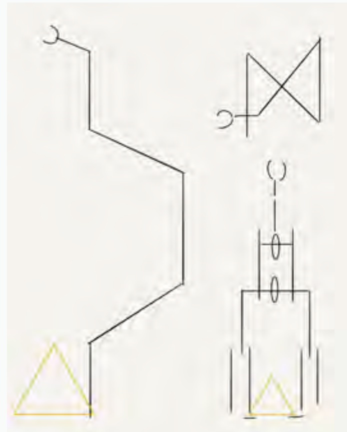
04 M Complete Mobile Goal Lift

- Attached motors onto the inside of the lift
- Joey had to cut a gear to use to secure the aluminum bars



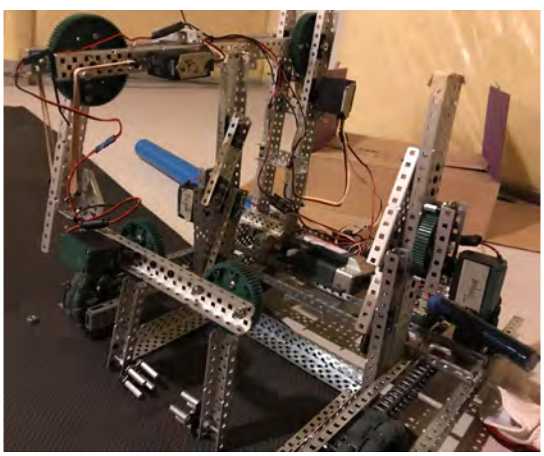
08 F Began Construction of the Arm

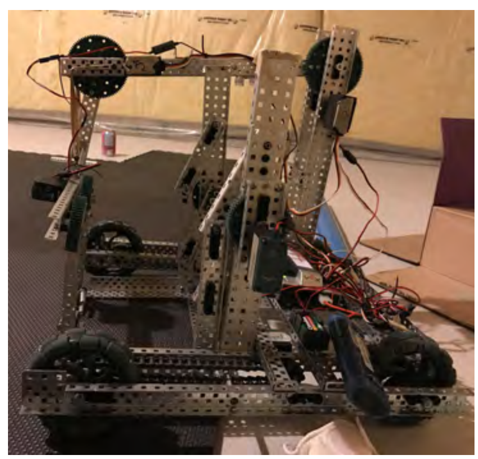
- We thought of a Christmas tree design to stabilize the arm attachment
- A new design idea is proposed by Jake what if we had the arm on both sides but not a double reverse. This would definitely more stabilize the arm
- The idea was put on hold as we must first make sure that we have enough materials to create one side of the deign first
- Alexis began building with a three bar base support
  - Soon realized that it would be impossible as there would be no space to attach the arm onto the base as it could only be attached onto one side of it



09 S Complete Arm Construction

- Double bar for shoulder and elbow
- 1:7 gear ratio for both the shoulder and the elbow
- Attached our fidget spinner concept claw back onto the robot
- Claw now only moves on one side rather than both sides as we don't have enough gears and this simplifies operations
- Rubber Bands are added to help support the elbow as the metal is heavy and the singular motor is not strong enough





11 M Devised Programming Strategy for Arm

- The arm was surely going to be difficult to program due to the number of joints it had
- Unfortunately due to the time constraint there was little we could do except map the rotation of each joint to a set of buttons on the controller
- To make driving easier, we wanted the arm to at least automatically remain parallel to the ground at all time. Unfortunately this idea was postponed to a later date due to lack of time

15 F Continued to Program

- Finished programming the arm of the robot
- Each joint of the arm mapped to a set of button on the controller allowing the joint to move up or down
- simple and straightforward, but slow

16 S Competition Day #2 - Brampton

- Some unidentified issue with the code occurred in beginning or the competition rendering our robot motionless during the matches
- The code was fixed and robot was functional for that remainder for the matches
- Robot was noticeably slow as the driver lacked practice due to time constraints
- We were chosen as the first pick by the very last alliance captains
- At the quarter finals, the robot's arm was pulled back too far by the elastics and the motors weren't strong enough to bring it back so it was just stuck

17 S

Reflection #2

What we did well on:

- Mobile Goal intake is again very consistent and reliable
- Talked to good people
- we were able to achieve our goal of stacking stationary goals

What did not go so well:

- We were chosen as first pick by the last alliance
- The claw made it difficult to grip
- Still no autonomous
- Not enough practise from the driver
- not using a preload element for majority of the games
- The mobile goal lift and arm combination was difficult in the sense that it did not really allow for good internal stacking, therefore operations were slow during the matches and internal stacking was not used
- At times, the elastic bands would completely come off if the arm reaches a certain position

What we learned:

- The various types of encoders (how Quad Shaft encoders work and how they should be what we are using)
- Why the motor encoders that we have been using are the worst type of encoders and how they build up static friction

Our goals for the next competition:

- Have a non-gravity based claw for more stable operations
- Add on a wrist to the arm in order to have a non-gravity based claw
- Strengthen the shoulder and avoid the use of rubber bands
- Code an autonomous programming

27 | 02 W-M

Strengthen Our Robot

- An extra motor is added to the shoulder and the elbow
- Gear ratios did not change, but added motor dramatically helped stabilize the originally flimsy and weak arm
- The arm could now hold and grasp without gravity pulling it down
- This simple solution was a step in the correct direction
- Some attachment cables broke, and we reattached using duct tape

JANUARY 2018

02 2 Gearing Up with Sensors

- added quadrature encoders to the shoulder and elbow, allowing for accurate sensor values for the very first time
- programmers rejoiced — better sensors meant that programatically solving problems would me so much easier and more reliable

04 T New Claw

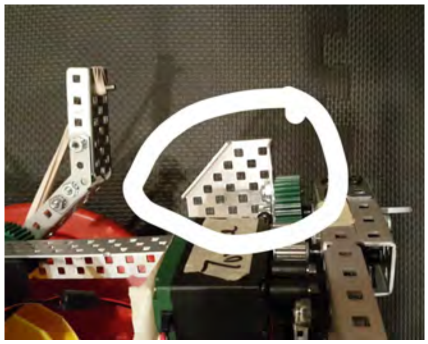
- We decided to go with a traditional claw that would be able to grip the sides of our robot
- We did not want anything big or heavy, there are two simple aluminum bars held together by a 45 degree angle attachment
- Elastic bands were added for gripping the robot
- 2 36 tooth gears were used to control the 2 sides of the claw

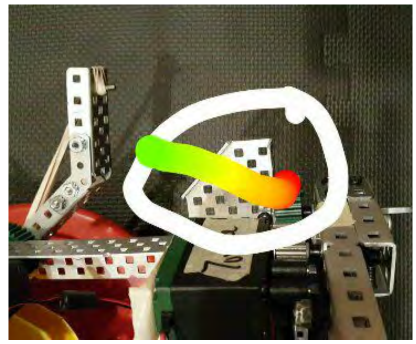
05 T Wrist Added

- 1:1:3 gear ratio for wrist
- slightly sketchy, slightly wobbly
- Allowed for more flexibility
- The robot for the next competition is pretty much complete and ready

08 M Driving Practice

- For the first time, the driver had time to practice before a the competition
- As Jonathan was practising, he also had to do a bit of cutting and fixing





09 T Claw Change

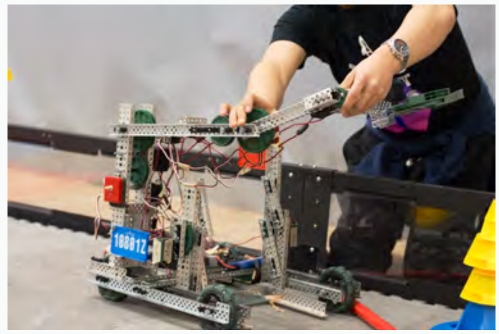
- The new elastic enclosure claw design was too heavy still causing out robot to sag to one side
- Despite an already lightweight design, the clawbot claw as a plastic component that was still much lighter while offering the same degree of functionality

12 F Autonomous Programming

- As promised, the new encoders made programming for autonomous so much more precise
- We created a 7 point autonomous where the robot could drive up to the stationary goal and accurately place down a cone on top (2 points from placing the cone and 5 points for achieving highest stack at that moment on the stationary)
- The lots of practise made our driver very strong

13 S Competition #3 - Barrie

- We did really well for the first time due to a combination of driver practicing and autonomous
- The robot performed very well, having very little technical issues
- Ranked in the top 5 for the qualifying rounds and had the potential to have a very good alliance
- Unfortunately the team with the robot that perfectly complemented ours were picked by a different team before we could pick them
- Overall very satisfied with this competition



14 S Reflection #3

What we did well on:

- Just about everything went as planned for the first time
- ranked in the top 5

What did not go so well:

- Didn't have the alliance we hoped to have
- Our autonomous didn't have something that scored as high as we wanted
- The driver still took too long possibly due to the claw require too much precision
- Couldn't use the loader very quickly or efficiently

What we learned:

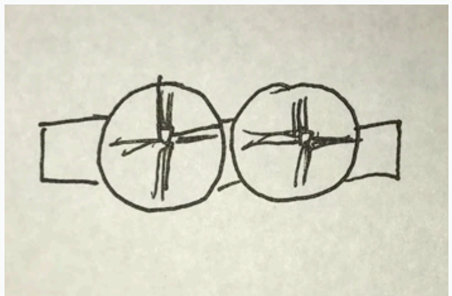
- We are competent after-all!

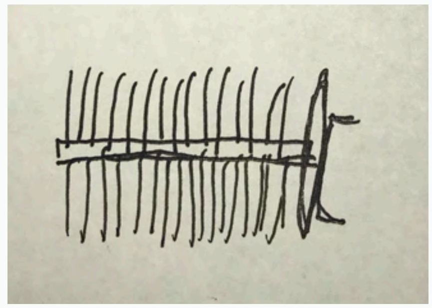
Our goals for the next competition:

- Change the claw to something that allows for more accessibility
- Considering rolling intake
- Using the new encoders, create an way to use the loader automatically

19 F Claw ➜ Rolling Intake

- Configured the new design on how we would do it
- Listed out a number of options: normal elastics with sprockets, braided elastics, zip-ties on long shaft
- Due to our lack of the correct size sprockets, we have concluded on using a multitude of zip-ties to complete our rolling intake





29 M Rolling Intake Completed

- Unfortunately due to exams, it set us slightly back in schedule
- The new intake was attached to our bot and tested
- It works very well actually

30 - 31

Autonomous Programming

- Joey spent many many many days trying to provide us with a better autonomous, unfortunately, due to a lack of more quad encoders, the values are incorrect and cannot be calculated
- Many days of trial and error
- An Ultrasound is added at the front of the robot, right behind the Mobile Goal lift in order to measure out distance
- However we found the ultrasound to be very unreliable at times as many of the objects this year is NOT flat, therefore the reflection of ultrasound messes with the distance calculation

FEBRUARY 2018

01 T

Autonomous Programming

- Joey and Jonathan went to another school in order to test and practise the autonomous on an actual VEX field, something that our school does not have the luxury of being able to afford
- The motors on the drive were changed from regular motors into encoder motors in order to calculate and measure the driving distance
- Due to this change in motor, the power is different, and therefore the code that we have spent so many days writing becomes ineffective
- All code must be rewrote

02 F

Robot Fails

- The autonomous still will not work
- We have not yet prepared ourselves for using the Loader
- It is currently impossible to get the robot completely ready for competition
- The team decides that it is not optimal to participate in the competition at around 7PM, therefore all operations towards advancing the robot is halted

03 S Competition #4 - Mississauga

- Because the robot failed and we ceased to be competitive, we were not initially planning on competing, however due to a twist of events, we did compete
- As expected we performed poorly (but still significantly better than the first few competitions which goes to show our improvement)

04 S Reflection #4

What we did well on:

- We used the loader without pre programmed code to make it automatic
- we were able to make a 6 stack during a game

What did not go so well:

- Everything else
- No Auton

What we learned:

- We are competent after-all!

Our goals for the next competition:

- We simply had to make our robot work again.
- We don't count this as an actual competition considering we were not expecting to compete

- We took this day to fix up the bristles of our rolling intake as during the competition, the cones fell out relatively easily, therefore was ineffective
- We fixed the wrist as the 1:1:3 gear ratio was very insecure, therefore changing it into a 1:5 high torque ratio

09 F Loader Programming

- The coding to assist our robot in efficiently grabbing cones off the loader and then internally stacking it is complete
- The code allows the driver to stack 4 cones automatically with 3 simple buttons

10 S Competition #5 - Toronto

- Our last chance to make it to Provincials
- Our chance to shine!

```
//the value we want to pass to the task
int valElbow = 0;

//the task (that cannot take parameters)
task moveElbow(){
    if(SensorValue[armSpinner]<valElbow){
        motor[elbow1]=motor[elbow2]=-127;
        while(SensorValue[armSpinner]<valElbow) wait1Msec(1);
    }else if(SensorValue[armSpinner]>valElbow){
        motor[elbow1]=motor[elbow2]=127;
        while(SensorValue[armSpinner]>valElbow) wait1Msec(1);
    }
    if(SensorValue[armSpinner]+SensorValue[spinner]<-50)
        motor[elbow1]=motor[elbow2]=15;
    else motor[elbow1]=motor[elbow2]=-15;
}

//the method that calls the task, but can take parameters
void elbowDist(int target){
    valElbow=target;
    startTask(moveElbow);
}
```

//We devised a clever strategy for running our robots. Because tasks can be run simultaneously they hold a significant advantage over methods which must happen in order, running one after the other. However, tasks cannot take parameters so our solution was to have a method does take a parameter, set the global variable or value we want to pass to the task, and then calls the task. This effectively creates tasks that can take parameters!

The method above allows us to move the elbow while also moving other parts of the robot. Using the sensors, this method moves the elbow to a specific position based on the value given by the sensor. We used more or less the exact same method for the shoulder and wrist.