Team 750 Blitz Engineering Notebook

Table of contents

Table of contents 2

Morphology Chart 4

Visual Morphology Chart 5

Potential Designs 8

Lift 9

Intake 10

- Pincers 10
  - Pros 10
  - Cons 10
- Claw 10
  - Pros 10
  - Cons 10
- Forklift 10
  - Pros 10
  - Cons 10

Shooter Intakes/Outputs 11

- Double Flywheel 11
  - PROS 11
  - CONS 11
- Single Flywheel 11
  - PROS 11
  - CONS 1
- Linear Shooter 11
  - PROS 1
  - CONS 1

Fielding Intake 12

Autonomous 13

Tele-op 14

Intake and Drive 15

New Autonomous 16

Daily Log for meetings 17

Morphology Chart

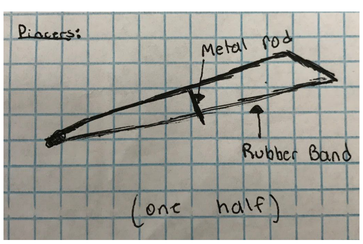
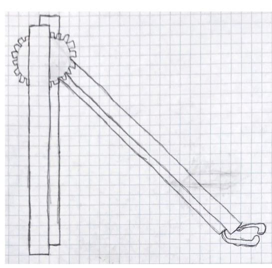
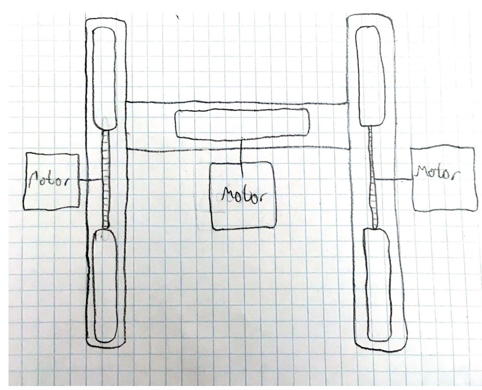
Authors: Rakesh Warrier, Aakash Prasad, Sudarshan Seshadri, Shaurya Gunderia, Adithya Swaminathan Zacharry Soriano, Aditya Chenji, Adhit Thakur

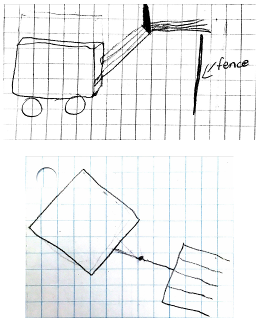
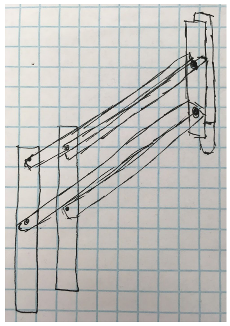
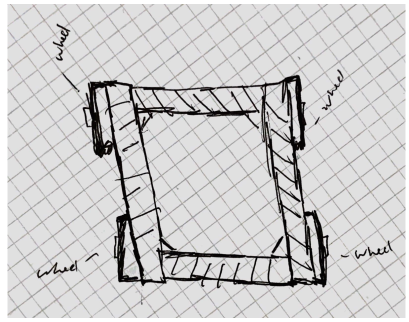
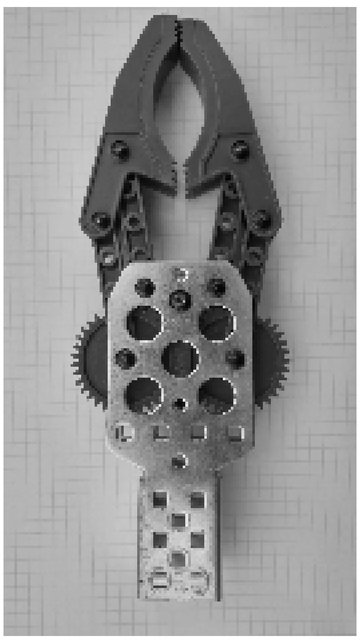
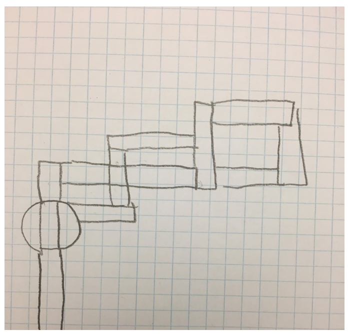
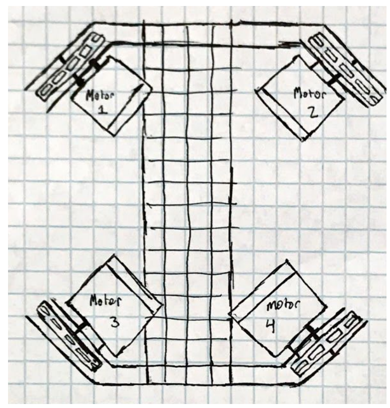
Date: July 20th

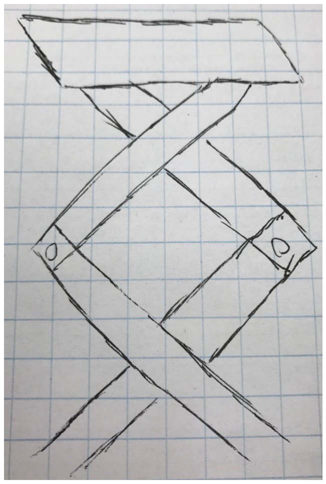
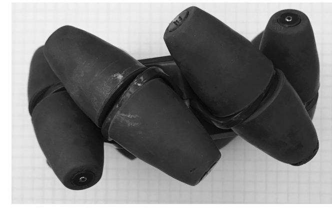
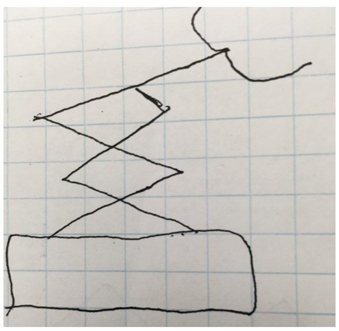
Intake	Lift	Drive	Wheels
Big claw(Pincers) <u>Pros</u> Can grab caps easily <u>Cons</u> It's less precise Need to be very precise to flip	**2-bar** <u>Pros</u> Simple, easy to build, less things that could go wrong, faster <u>Cons</u> Not as maneuverable Not much reach	**H-drive** <u>Pros</u> Able to strafe More maneuverable <u>Cons</u> Harder to code Can't strafe fast enough	**Omni-Wheels** <u>Pros</u> More grip on the track Easy to strafe with <u>Cons</u> Does not strafe fast
Forklift <u>Pros</u> Easy to pick caps Easy to flip caps <u>Cons</u> Harder to build Less maneuverability	**4-bar** <u>Pros</u> Simple compared to some others <u>Cons</u> It's less precise, Much slower, complicated	**Tank-drive** <u>Pros</u> Easy to build Easy to code <u>Cons</u> SLOW Not as maneuverable	**Standard wheels** <u>Pros</u> Moves forward fast <u>Cons</u> Has friction Cannot strafe/move diagonal
Claw <u>Pros</u> Can easily pick up cap Can easily flip if 180 degree turntable or gear is added <u>Cons</u> It is useless to flip without 180 degree turn	**Reverse double 4-bar** <u>Pros</u> Reaches higher <u>Cons</u> Only viable with forklift COMPLICATED Flimsy when fully extended	**Holonomic-X** <u>Pros</u> Can move in all directions The most control and maneuverability out of all the drives <u>Cons</u> Harder to code Not easy to fix or change on the spot	**Rubber Wheels** <u>Pros</u> Moves kind of fast <u>Cons</u> Cannot strafe Lots of friction Harder to maneuver

Double Flywheel Pros Can shoot very fast Speed adjust angle easily Cons Takes up a lot of space on base **Linear Shooter** Pros Can shoot accurately Fast Cons Need to move bot back and forth to change angle **Single Flywheel** Pros Less space than double Fast Cons Not as accurate	**Scissor Lift** Pros Very good height Cons It's less precise Lot of parts-may be shaky and/or unstable Just straight up **6-Bar** Pros Can reach very high Cons Height may not be necessary Extra weight- may be slower Harder to build	**West Coast** Pros Good to get on platform - 6 inch Less wheels Cons Kind of unstable at times	**Mecanum Wheels** Pros Has lots of traction Can strafe diagonally Cons Very Bulky Very Hard to go straight

Visual Morphology Chart

Intake	Lift	Drive	Wheels
Pincers 	**2-bar** 	**H-drive** 	**Omni-Wheels** 

Forklift  	4-bar 	Tank-drive  	Standard wheels 
Claw 	Reverse double 4-bar 	Holonomic-X  	Rubber Wheels 
	Scissor Lift		Mecanum Wheels 

			
	6-Bar 		

<u>Potential Designs</u>

Author: Rakesh Warrier

Drive

West Coast - Drive

Pros	**Cons**
- Maneuverability - easy to get on platform	- May wobble due to instability, especially when lift is fully extended

Tank Drive

Pros	**Cons**
-Faster Linear Movement -Simple to build -Simple to code	-Not as maneuverable - harder to get onto middle platform

H-drive

Pros	**Cons**
-Able to strafe -More maneuverable	-Harder to code - harder to get on platform - waste of a motor

We chose to do a west-coast drive because easy to get on the platforms, and not hard to change if we decide to go with another drive on the list.

Lift

Author: Rakesh Warrier

Cascading lift

Pros	Cons
- Unique - Great for vertical motion - Works well with forklift	- Has to be placed on the back of robot to work properly - Heavy

4-Bar

Pros	Cons
- Goes higher than 2-bar - Stays Straight - Stable	- It's less precise than 2-bar - Much slower than 2-bar

Scissor lift

Pros	Cons
- reaches high - Open space in middle for shooter	- At the top a little unstable - Requires lots of c-channels

We picked a cascading lift because it is a great lift for vertical motion, and it is compact enough to fit the shooter on the other side and it also fits well within 18x18x18.

Intake

Author: Rakesh Warrier

Pincers

Pros

-Precision placement for caps on posts

-Intake and scoring mechanism

Cons

- Big and bulky
- Will be hard to rotate with 180 degree turn
- Hard to flip cap

Claw

Pros

- Exact size for cap
- Can maneuver easier
- Less materials or pre-made

Cons

- Need 180 degrees to flip cap
- Cannot flip caps easily

Forklift

Pros

- Easy to pick cap
- Easy to flip cap

Cons

- Caps can fall easily during transfer to post
- Kind of flimsy

We chose a forklift because it goes best with the cascading lift and it is great for manipulating caps.

Shooter Intakes/Outputs

Author: Rakesh Warrier

Double Flywheel

PROS	CONS
- Fast - Accurate - Change angle easily using speed change	- Takes up a lot of space on base - Only can be used effectively with scissor lift (space-wise)

Single Flywheel

PROS	CONS
- Fast - Accurate - Changes speed to change angle easily - Less space than double	- Uses one whole motor for one wheel - May overheat motor

Linear Shooter

PROS	CONS
- Accurate - Fast - Least amount of space needed	- Need to move bot to change angle

A single flywheel was best based on the amount of motors we have available. A double flywheel would need two to be effective. We also felt that the single flywheel was a more unique choice since most people would pick the double flywheel or the linear shooter.

Fielding Intake

Author: Aakash Prasad and Rakesh Warrier

Funnel with conveyor belt

Pros	Cons
-Easy to implement	-Not very accurate

Sprockets with rubber bands - flywheel internal

Pros	Cons
-Faster than funnel -more consistent	-Rubberbands can snap and make intake useless -Unstable if built incorrectly

Rubber pinion roller - conveyor belt

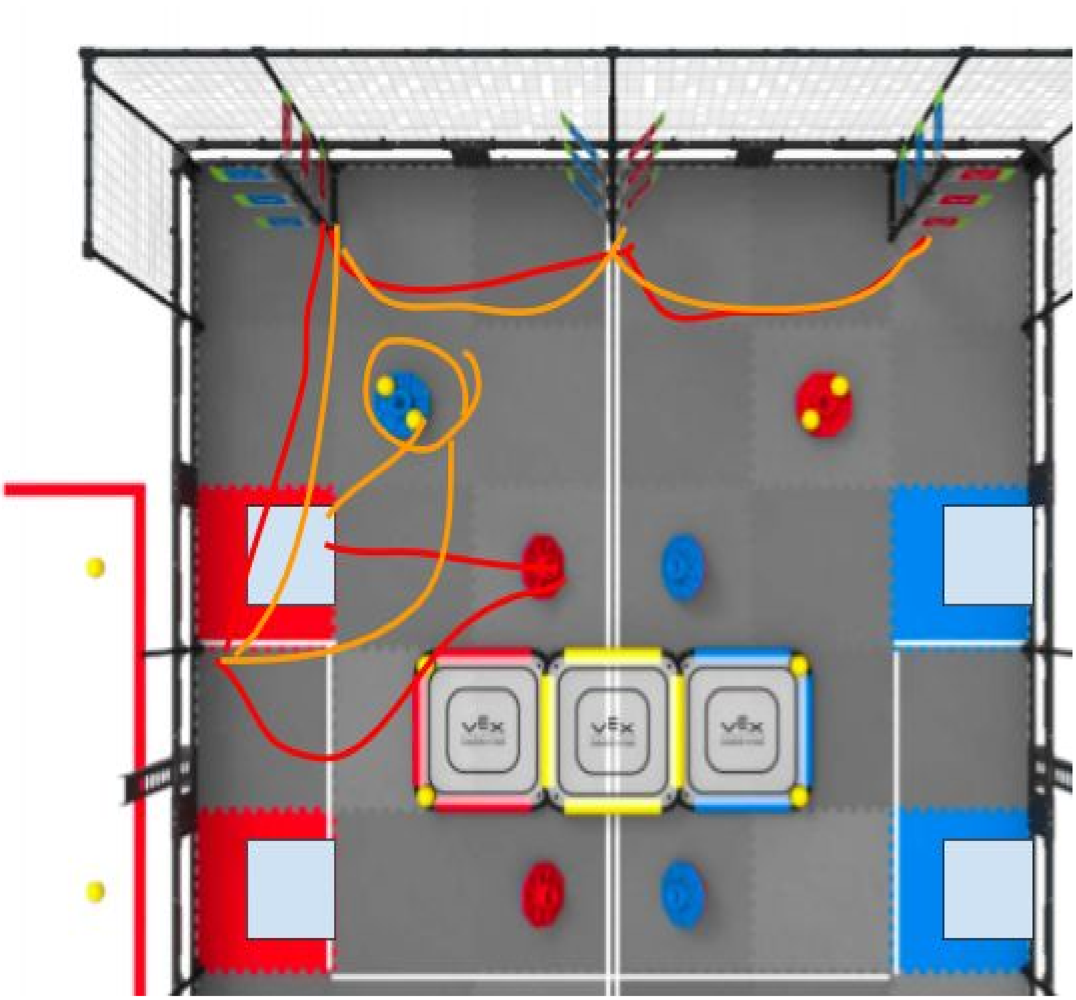
Pros	Cons
-Faster than funnel -Less likely to break than flywheel	-It is difficult to place the pinions and change the space without redesign

The rubber pinion rollers are great for picking up the balls, and the conveyor belt works great in a compact space to get the ball from the intake rollers to the single flywheel shooter.

Author: Rakesh Warrier

Autonomous

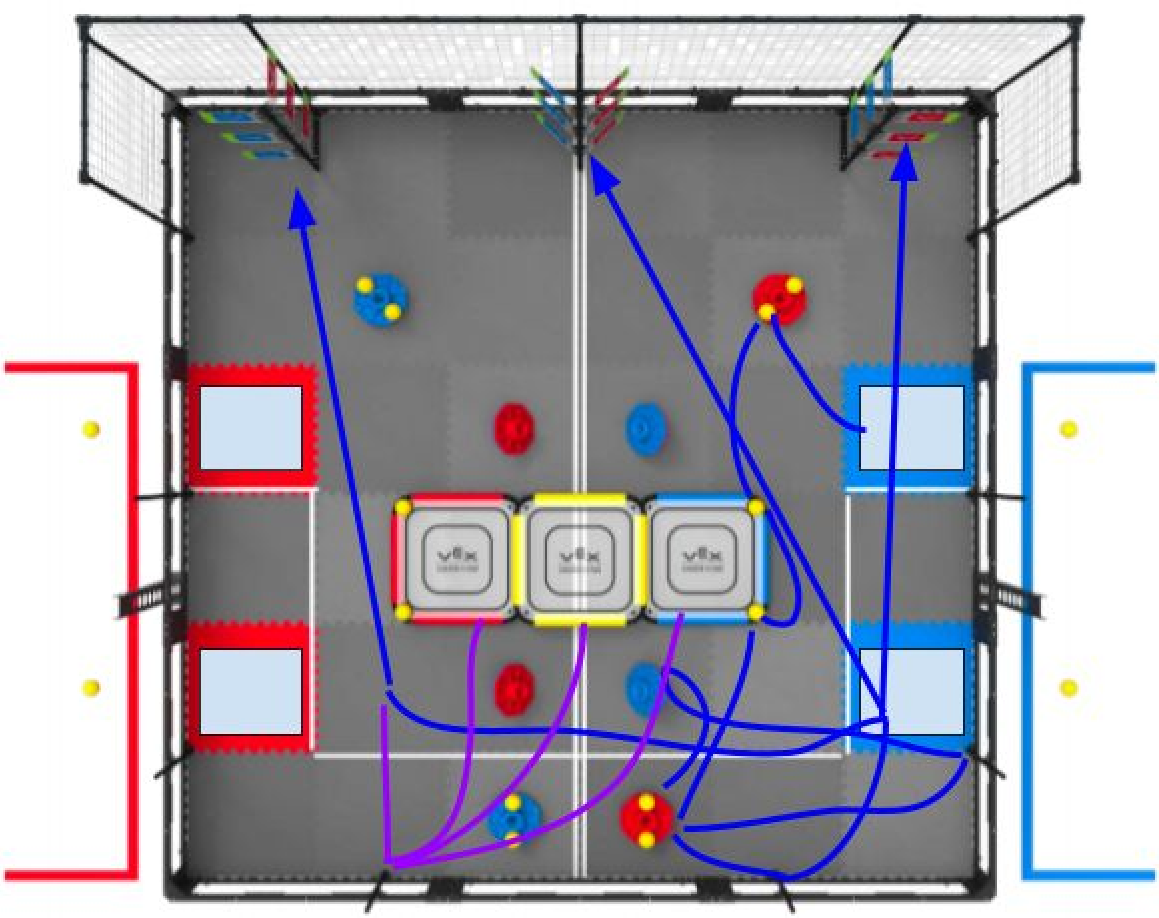
Our idea for an auton would be to grab the nearest cap for with our team color, pick it up, expand, and then place it on the post. Then we would go and push the low goals in our favor (indicated in red). Another idea for the first part would be to go to the nearest cap, flip to our color and then place it on the post (indicated in orange). *POV of Red alliance*



Author: Rakesh Warrier

<u>Tele-op</u>

Our idea for Tele-op is to focus on fielding 2 balls first in our shooter. Then we would take caps and put them on posts for as many as we can. After that we would then shoot the balls at the flags to go in our alliance's favor (indicated with blue). During end game our plan is to doing any last minute scoring with posts and flags, and then we would try to go for platforms in the middle. Best case scenario we get the middle high platform, but other than that we are aiming for any of the platforms (indicated with purple). *POV of Blue alliance*



Author: Sudarshan Seshadri

Intake and Drive

Intake:

Drive: West Coast Drive

- Make the middle wheel larger/lower so that it is easier to park the bot on the platform.
- Better for close quarter turning

Intake: Two Pronged fork lift

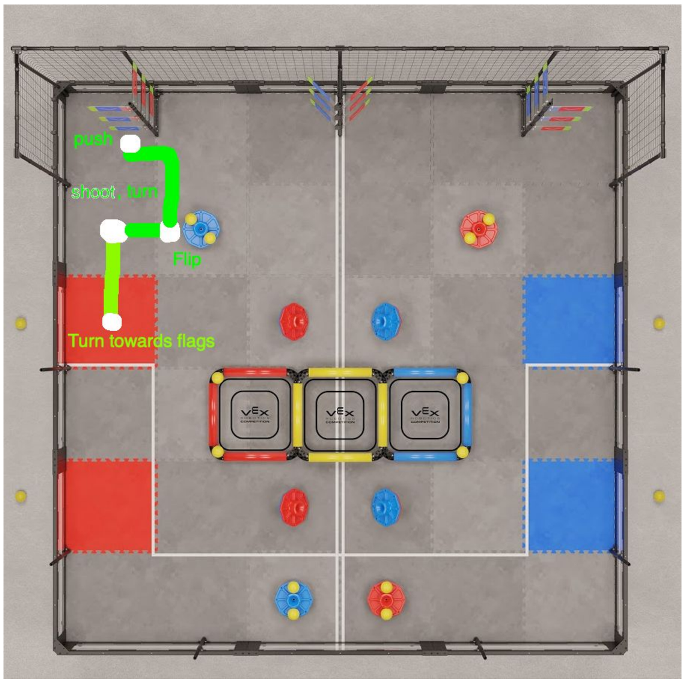
- Can make the intake in a way that the cap can be flipped after picking them up.
- Best for flipping caps on posts

Author: Sudarshan Seshadri

New Autonomous

Now that our bot is incapable of putting caps on posts, we must make a new auton. We will first shoot at the middle flag. Then, we will go to the initial cap as shown, turn left, and then drive into the bottom flag to the left.

POV of Red alliance



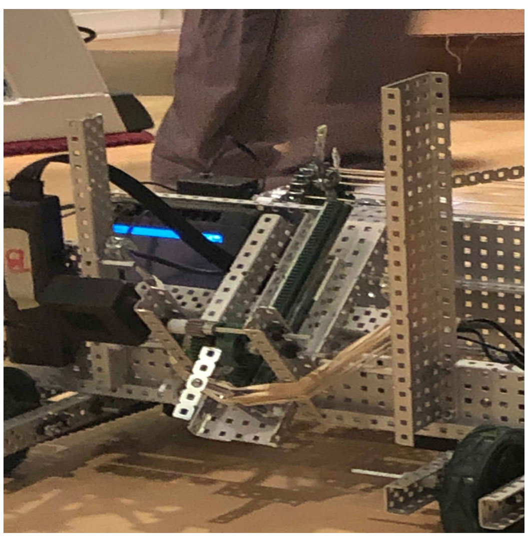
Author: Adhit Thakur

New Drive

Before, we had a West Coast Drive. We believed that this drive would provide a stylistic property to the robot, and would allow it to go on the platform. In the competitions, we realized that this drive lacked efficiency, and the style did not make up for this insufficiency. As a result, for the South Brunswick competition, we changed the drive to a 6 wheel drive, where the wheels in the middle are smaller. This drive is much more efficient, and can go on the platform. The middle wheels act as traction when elevating on the platform.

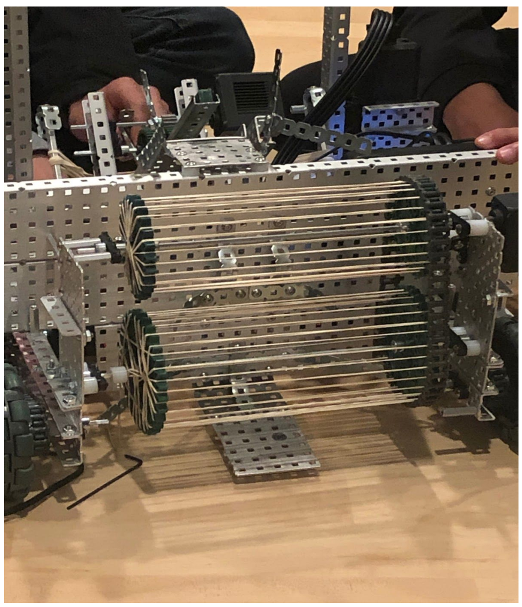
New Shooter

Previously, our shooter was a single flywheel shooter. We felt that this shooter would provide the optimal amount of force for the ball to hit all of the flags. In the competition, we realized that the flywheel shooter did not have the range that we needed. Because of this, the shooter was changed to a linear shooter, for more force, and range.



New Intake

Before, our intake was not as efficient. It involved a single flywheel, and the ball going on top of a metal rod. Then the ball would be shot at an angle. Throughout the initial competitions, we noticed that even though this intake was functional, it did not provide the power that could compete with the other teams. In order to do this, we created a system with four gears, and rubber - banding. The ball would go on a platform, and the linear shooter would operate. In the early stages of the intake, the rubber bands would break off the intake, because the flywheel would spin too fast. As a result of this, we replaced the regular rubber bands with thicker rubber bands, to prevent the breaking.



New Lift

Our original lift was a cascade lift. We felt that this lift was perfect for the game Turning Point. This is because it combined elements of sturdy with efficiency. For the SB competition, we removed the lift from our robot, because the other aspects took too much space. We wanted to focus on shooting the ball and flipping caps (primary focus being flipping the caps). For the Milburn competition, we will add a lift, that will act as a de - scorer also.

Daily Log for meetings

Date: July 20th

Activities:

- First meeting
- Went over bylaws
- Signed bylaws
- Discussed team name and logo
- Came up with ideas for bot

Date: August 4th

Activities:

- Finalized team name and logo
- Designed ideas for bot
- Discussed strategy for auton
- Discussed strategy for tele-op
- Started working in Engineering Notebook

Date: October 27th

Activities:

- Finalized design for robot
- Worked on auton code for robot
- Surveyed the V5 system and tinkered with it
- Started to build robot

Date: November 6th

Activities:

- Made the base: a west coast drive
- Tested driving over obstacles
- Worked on the website

Date: November 24th

Activities:

- Made the base: a west coast drive
- Tested driving over obstacles
- Worked on the website

Date: November 25th

Activities:
- Tightened the chain on the west coast drive
- Started cascading lift

Date: November 27th

Activities:
- Worked on cascading lift
- Created forklift for cap manipulation

Date: November 29th

Activites:
- Finished cascading lift
- Tested cascading lift

Date: November 30th

Activites:
- Worked on problems with cascading lift that came up
- Attached cascading lift to drive
- Attached forklift to cascading lift
- Tested full robot
- Participated in scrimmage and meeting with other SB teams:
    - 750 C
    - 750 R
    - 750 W

Date: February 1st

Activities:
- Fixed the rubber bands breaking
- Increased speed of the intake

Date: December 10th

Activities:
- Worked on the shooter (conveyer belt)
- Adjusted and worked on the sides of the drive (fixed areas of tension)
- Worked on part of the lift (extending the length so it can grip onto the caps, making it like a hinge)
- Made sure that the sides of the drive are uniform

Date: December 14th

Activities:
- Worked on shooter
- Worked on lift
- Fixed cap intake mechanism

Date: December 22nd

Activities:
- Worked on the code
- Worked on shooter
- Fixed complications with the lift

Date: December 23rd

Activities:
- Worked on the code
- Worked on shooter
- Made lift double chained

Date: January 4th

Activities:
- Worked on the code - finished op control
- Tested the shooter
- Worked on the lift
- Part of the drive was hitting the wheel, so it was moved forward.
- Mentored a team of freshmen
- Worked on online challenged

Date: January 6th

Activities:
- Worked on the auton, which uses the vision sensor
- Fixed and reassembled the lift
- Made a gearbox for the shooter
- Worked on the online challenge song - chose the background and started working on lyrics.

Date: January 11th

Activities:
- Worked on the auton, which uses the vision sensor
- Took off lift
- Changed shooter to be more compact and closer to the ground
- Started making intakes for the shooter

Date: January 12th

Activities:
- Worked on the auton, which uses the vision sensor
- Worked on mounting the shooter onto the base
- Made more support for shooter and drive

Date: January 13th

Activities:
- Finished up auton
- Made some changes to the tele-op
- Created a fork to flip caps instead of a dysfunctional lift

Date: January 15th

Activities:
- Worked on a new button within the tele-op
- Tested the fork created last meeting
- Made some iterations to the fork to increase cap flipping accuracy

Date: January 16th

Activities:
- Came up with ideas to intake ball into shooter

- Started rubberbanding the intake for the shooter
- Added anti-slip mesh to the fork

<u>Date:</u> January 17th

<u>Activities:</u>
- Finished rubberbanding the intake
- Took apart the lift to use the chain for a more efficient intake (less motors)
- Placed the intake within the robot and positioned it accordingly to reach the single flywheel
- Made some code for the tele-op to run the intake

<u>Date:</u> January 18th

<u>Activities:</u>
- Created guides for the intake so the ball will not get stuck somewhere else
- Fixed the chain linking the intake rubber band rollers
- Plugged in motors and sensor
- Used rubber bands and zip ties for cable management
- Placed license plates on
- Participated in a scrimmage with all other SBCREW teams

<u>Date:</u> January 23th

<u>Activities:</u>
- Discussed plans for a bot redesign
- Decided on the following design:
    - 4 Wheel tank drive
    - Linear Shooter

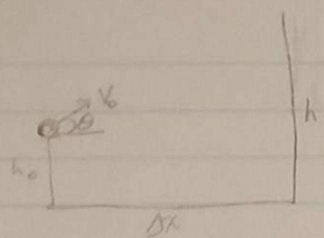
<u>Date:</u> January 28th

<u>Activities:</u>
- Built intake for shooter
- Continued building linear shooter

<u>Date:</u> February 6th

<u>Activites:</u>
- Increased stability on the robot
- Increased the amount of driver practice, by flipping caps and shooting the ball.

Author: Aakash Prasad
Flywheel Calculations:



$$\tfrac{1}{2}mv_0^2 = \tfrac{1}{2}I\omega^2$$
$$mv_0^2 = \tfrac{1}{2}M\omega^2$$
$$v_0 = \sqrt{\frac{M\omega^2}{2m}} = \omega\sqrt{\frac{M}{2m}}$$

(off ground)

<u>flag heights</u>: 9.125
9.125 + 13.25 → 22. 3
9.125 + 13.25 + 13.25
→ 35. 6
↳ 0. 90

$$\Delta x = v_0 \cos\theta\, t \qquad \Delta x = \left(\omega\sqrt{\frac{M}{2m}}\right)\cos\theta\, t \qquad \Delta y = h - h_0 \qquad \theta = \sin^{-1}\left(\frac{h - h_0 + \frac{1}{2}gt^2}{\omega\sqrt{\frac{M}{2m}}}\right)$$

$$\Delta y = v_0 \sin\theta\, t - \tfrac{1}{2}gt^2 \qquad \Delta y = \left(\omega\sqrt{\frac{M}{2m}}\right)\sin\theta - \tfrac{1}{2}gt^2 \qquad h - h_0 = \left(\omega\sqrt{\frac{M}{2m}}\right)\sin\theta - \tfrac{1}{2}gt^2$$

$$\Delta x = \left(\omega\sqrt{\frac{M}{2m}}\right)\cos\left(\sin^{-1}\left(\frac{\overbrace{(h - h_0)}^{\Delta h} + \frac{1}{2}gt^2}{\omega\sqrt{\frac{M}{2m}}}\right)\right)t$$

$$\to \Delta x = \left(\omega\sqrt{\frac{M}{2m}}\right)\cos\left(\sin^{-1}\left(\frac{(\Delta h + \frac{1}{2}gt^2)\sqrt{2m}}{\omega\sqrt{M}}\right)\right)t$$

h = height from ground of flag
h_0 = height of shooter
ω = [rad/s] angular velocity of flywheel
t = time to flag
M = mass of wheel × 2 (2 wheels on each) → ~200g = 0.2kg
m = mass of ball = 55g = 0.055kg

Max output of motor: 600RPM

$$\omega = \frac{600\,\text{rev}}{1\,\text{min}} \cdot \frac{2\pi\,\text{rad}}{1\,\text{rev}} \cdot \frac{1\,\text{min}}{60\,\text{s}} = 20\pi\ \text{rad/s}$$

$\Delta h = 0.904875 - (13\text{in} \to 0.08$
$\Delta h = 0.520\,8$

<u>high flag</u>: $\Delta x = \left(20\sqrt{\frac{0.2}{0.055}}\right)\cos\left(\sin^{-1}\left(\frac{(0.520875 + (4.905)t^2)(\sqrt{2(0.055)})}{(20\pi)(\sqrt{0.2})}\right)\right)t$

***Disclaimer*:**

The calculations here assume no air resistance, which is not an entirely negligible in real world applications, but for ease of use, and considering the smoothness of the ball, it is not considered.

All values that are used in the calculations, such as mass, radius, or torque, are all from the VEX website, and are the numbers given by the company itself.

Explanation:

I first started off by tailoring all of the big 4 kinematics equations to the given variables in this system. I assumed no drag force, so the x- component of the velocity is constant, and the y velocity is only affected by gravity. Since the ball is not traveling very fast, and drag force is usually dependant in some degree on velocity, it is excluded. Since gravity is a conservative force, I was able to apply conservation of energy, and converted the rotational kinetic energy of the flywheel into translational kinetic energy of the outgoing ball (this is also not ideal and would not be exact - close enough). I then substituted all the variables in so that we could have as little variance as possible. When finished, I had a function to find the horizontal distance that we needed to be away from the base of the flag, so that we could hit the high flag.

Author: Aakash Prasad

The Linear Puncher:

The linear puncher works as follows:

There are 3 main components that go into making a puncher.

- **Slide**
- **Slip Gear**
- **Rubberbands**

Slide:

The slide and the rail are self explanatory - as the rail moves, it is guided by the slide - it is designed to be smooth, but fearing it was not smooth enough, my team and I decided to sand down the inside of the rail using a dremel: reducing friction significantly.

Slip Gear:

The slip gear is the component to this that turns it from an ordinary rail and slide to a puncher. We took a 36 tooth gear and sanded off about 12 teeth, so that it was completely smooth for a section of it; when the rail is being pushed by the gearbox, and this slip gear in particular, it is moving just like a normal slide at first, but when it reaches the sanded part, the gear skips, and slides down the rail.

Rubberbands:

The reason it slides down instead of just falling out, is that we used rubber bands to tension the rail so that as it pulls back, it gains elastic potential energy and when the slip gear is reached, it launches forward.