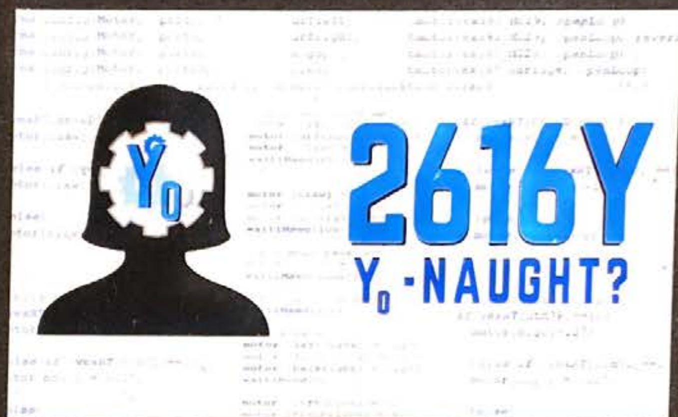
# ENGINEERING NOTEBOOK

#BUILTBYGIRLS

VEX WORLDS 2018

Team #: 2616Y
Division: Engineering
High School




# 2616Y

**Y-NAUGHT**

## ABOUT

- DR4B with a chain bar
- stationary highest stack: 6
- mobile goal highest stack: 11
- multiple autons for each zone

**FOR MORE INFO:**
**https://goo.gl/rLuRDf**

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Anthea Zheng

Color code: Building Days
Programming Brainstorming Days
Problems
Solutions
Strategy Days
Other

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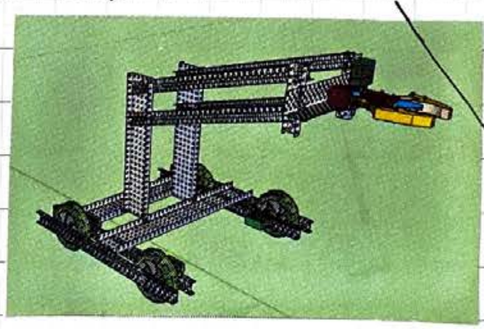
PRIMARY IDEA 8/21/17

For our first year participating in the In the Zone Competition, our focal point was to construct a robot based on speed and accuracy. Our goal for the competition is to push the cones into the mobile goals and stack as many cones as quickly as possible. Because we are aiming for a versatile robot, we decided to use the omni-directional wheels.

For our first trial robot, we designed a four bar lift to maximize speed to fulfill our initial design. Additionally, the four bar lift keeps the intake parallel to the ground, making it easier to stack the cones. After building the four bar lift, we will consider designing the six bar lift to maximize the height of the stacked cones. The reason why we did not consider the linear lift is that we need to be able to push the cones into the zones.

8/31/17

Before we started to look at final designs, we came together as a team to get the experience of building our first lift before entering the competition. We started with our primary design to construct the basic four bar lift.



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SECONDARY DESIGN 9/9/17

After reviewing our previous, we have discovered that in order to make our robot as efficient as possible, we will also need to include a mobile goal lift. However, the four bar lift that we were planning on designing would not be capable of stacking cones onto the mobile goal lift. Therefore, we are changing the four bar lift into a chain bar lift, so that the claw will remain parallel to the ground, which gives the robot the ability to stack cones onto the mobile goal lift.

No space for a mobile goal lift.

lk

We hope to stack approximately 3 ~~mo~~ cones onto the mobile goal lift. One mobile goal ~~lift~~ will be able to go to the 20 point zone and a second will be able go to the 10 point zone. ~~due t~~ The 20 point zone will be able to be reached due to the robot's increased height.

lk lk

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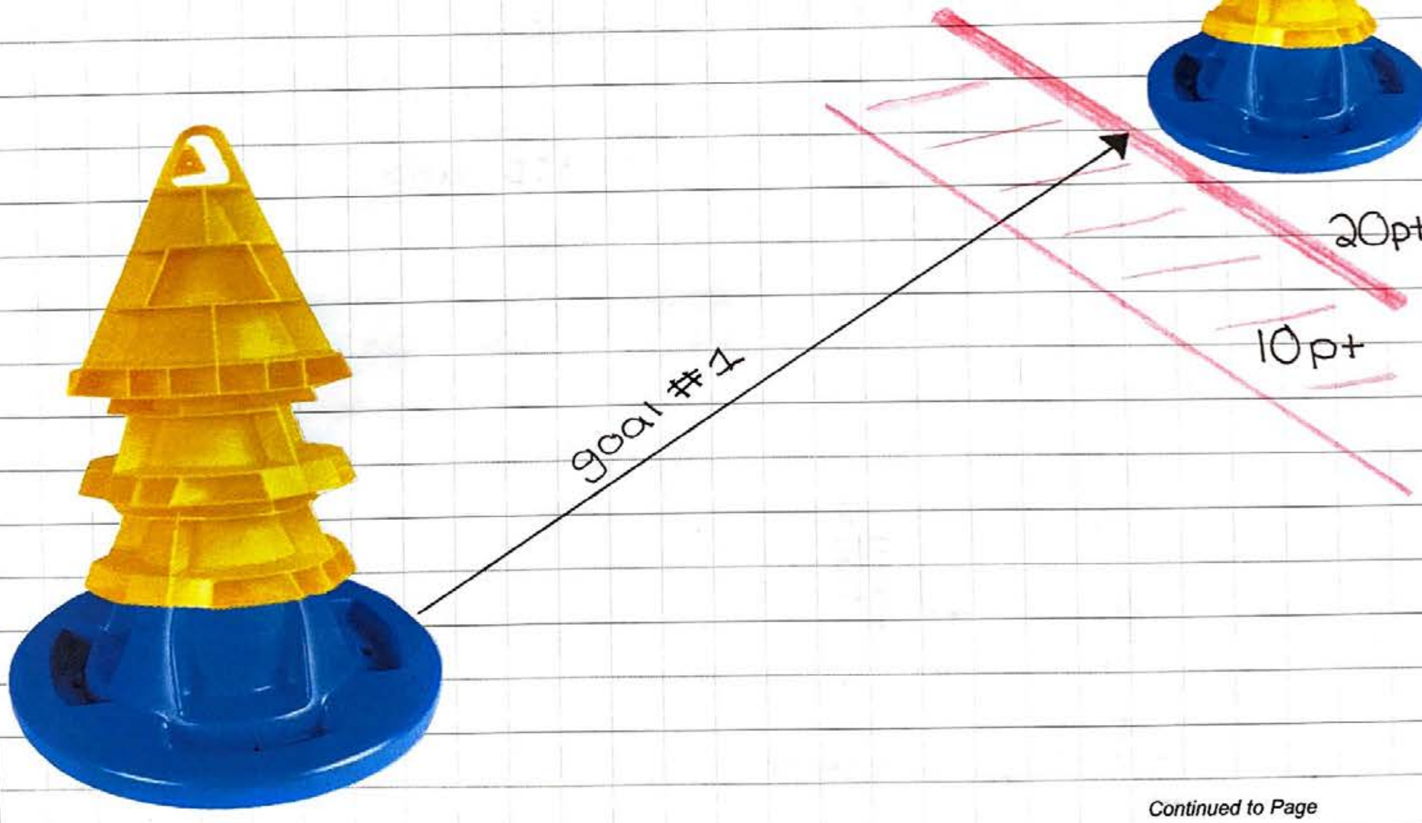
Game Strategy 9/11/17

The chain bar lift will pick up cones from the back of the robot and stack them onto the mobile goal lift in the front. Only 1 cone is able to be stacked on the stationary goal based on the maximum height that the chain bar will end up reaching, which will be around 30 in. After stacking the cones on the mobile goal on the robot, we will lift the mobile goal into the 20 point zone. Then, we will aim for the 10 point zone. Once the mobile goal is in the 10 point zone, we will utilize the remaining time to stack the cones onto the mobile goal in the 10 point zone.

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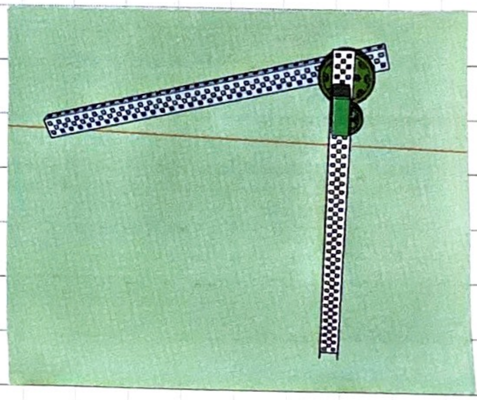
Brainstorming 9/19/17

Today, we are starting on our lift. Our first thoughts are focused towards the gear ratios that will be used to power the lift. Because the yellow cones only weigh 118 grams, we will not need to set the gears for torque. The ratio that we will be using is a 36:60 or a 3:5 ratio. The 36 tooth gear will be the input or driving gear, and the 60 tooth gear will be the driven gear or the output, which will be connected to the lift mechanism. We will be using a 1x2x1x30 c-channel for the base of the lift in order to maximize the height of the chain bar while still remaining within the 18" after it would be attached to the drive.


= 3:5 ratio



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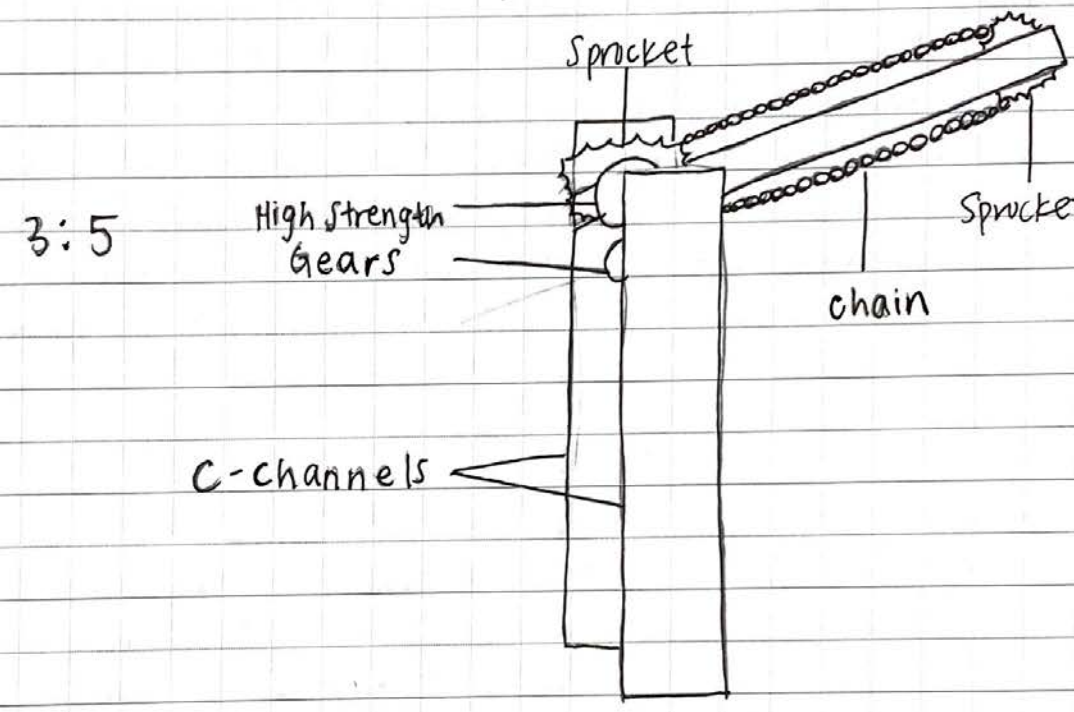
Lift Building 9/24/17

today, we are building the lift for the robot. We decided on the chain bar lift because it can reach greater heights compared to the four bar lift.




Problem: one side of the lift did not match the other side in width.

Solution: After reviewing our robot, there was a spacer missing on the left side of the lift.

Problem: the steel that made up the lift was heavy, which caused the lift to slam down forcefully

Solution: we replaced the steel parts with aluminum since it is lighter

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Programming 9/26/17

Having a solid understanding of C-based languages is essential to being able to program the robot regardless of what programming language we ultimately choose. And since most of us are still only beginners, it seemed like the best course of action was to start with the basics. In order to understand the various data types, while loops, booleans, etc. we used the site Fresh2Refresh on C-programming and C-basic programs. Once we mastered the basics, we honed in on ROBOTC. Specifically, we used Carnegie Mellon's ROBOTC portal, which offered a myriad of PDFs and videos, to further our knowledge of motors, ports, and sensors. Some other sites that we used include:

- education.rec.ri.cmu.edu
- robotc.net
- ntu.edu.sg

Initially, we planned on using the programming language, PROS. However, after spending multiple sessions using PROS, we realized that we simply were not making as much progress as we had hoped. That is, as beginners, we lacked the proper C-based knowledge to program in PROS. As a result, we opted for ROBOTC, a more user-friendly language that offered the same results. Of course, even with ROBOTC, we still dedicated hours upon hours strengthening our hold on basic programming functions and syntax.

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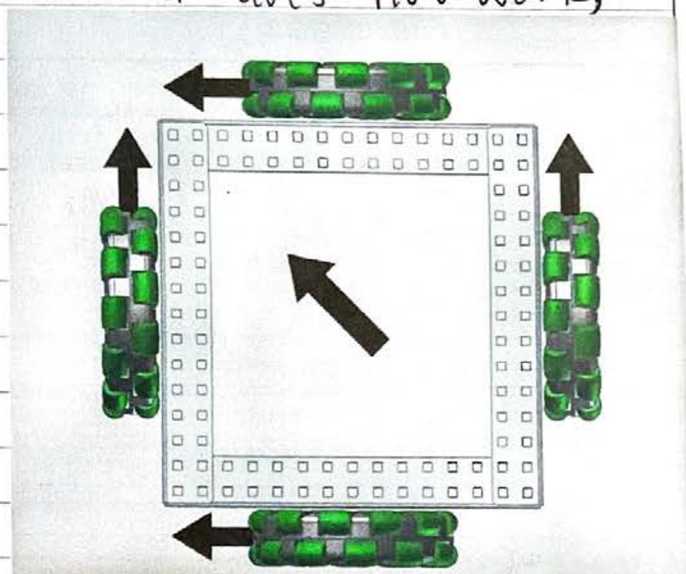
Brainstorming 10/1/17

The topic for today is to decide on which wheels to utilize for the drive. We are also discussing which style to use for the robot's drive. For example, the H-drive would suit our robot since we plan on using a mobile goal lift in our design. On the other hand, the U-shaped base would assist us in that it would give more room for the mobile goal lift. Ultimately, we decided upon utilizing the H-Drive because it is stable and compatible with our design. We decided against using the U-shaped base because the claw would hit the bar when picking up the yellow cones from the back of our robot if we used the U-shape. For the wheels, we decided upon omni-wheels since they are omni directional, indicating that it is able to turn in all possible directions. This is beneficial to our robot because one of the goals of our robot was speed. The best way to fulfill this is by allowing the robot to maneuver through the field smoothly with the freedom to turn in any direction. We were able to figure this out by viewing successful and less successful robots and techniques to know what works and does not work, from previous years and matches.

omni-wheels →
can go in all directions



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Drive Building 10/5/17

We are constructing the drive with 1x2x1x35 c-channels and running a 1x5x1x35 c-channel across the center for stabilization. Thus, this will ensure that the robot meets the 18" requirements. Additionally, we are using the omni-wheels to make quick turns for speed. These wheels allow for smooth rotations since they have very little friction, providing greater efficiency for the robot. On the other hand, the c-channels have strong properties, which prevents any dents or bending. Because the channels can be cut into smaller pieces with segmented 2.5" parts, we are able to modify the drive in regards to size and length. This is great for our robot since it must be sturdy without tipping or falling over. It is important to build the drive without any mistakes or careless mishaps because the drive sets the foundation of the entire robot. In other words, if a part of the drive is incorrectly assembled, then the risk of another part of the robot that sits above the drive falling off is present. Such parts could be the lift, and the reason for this is that the drive acts like the base of the robot. Thus, when building the drive today, we were careful in attaching and assembling the parts of the drive. Then, we checked to see that all screws and nuts were secured on tightly.

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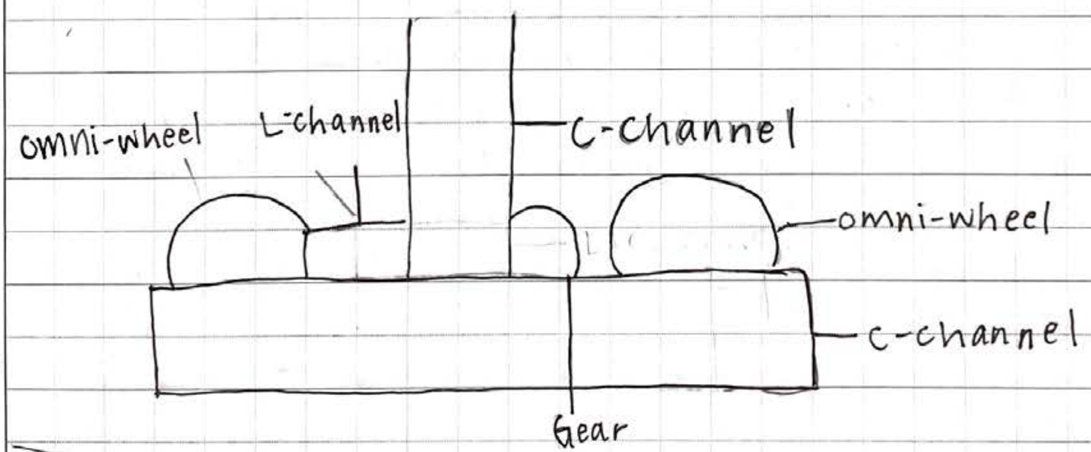
Drive / Lift Building 10/11/17

We are attaching the lift to the drive today. We are using 4 parts of an L channel with each having a length 5. This is so that we can effectively attach the lift to the drive. After learning that any vibrations cause the hex nuts to turn loose, we are using lock nuts for these structural purposes. The gear of the chain bar was screwed to the metal, and the circular inserts were inserted into the gears. This permits the arm of the lift to raise and move downwards while the gear turns. This motion and movement is critical since it will help us follow our game strategy: to pick up cones from the back of the robot and load them onto the mobile goal lift located in the front. The 180° motion of the chain bar lift will allow the robot to do just that, and the second 180° going down will come to a totall of 360°.

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## Drive Programming 10/14/17

```
task usercontrol()
{
#define Full_Power 127;
#define HALF_POWER 63;
#define STOP 0;
#define FL motor[frontleft]
#define FR motor[frontright]
#define BR motor[backright]
#define BL motor[backleft]
#define LIFT motor[armleft]

  while(true)
  {
    //joystick control:
    motor[frontleft] = vexRT[Ch3];
    motor[backleft] = vexRT[Ch3];
    motor[frontright] = vexRT[Ch2];
    motor[backright] = vexRT[Ch2];


   //lift control
   if(vexRT[Btn5U]==1){
     motor[armleft]=127;
     motor[armright]=127;

   }else if (vexRT[Btn5D]==1){
     motor[armleft] = -127;
     motor[armright] = -127;
   }else{
     motor[armleft] = 0;
     motor[armright] =0;

   }
   //claw control
   if(vexRT[Btn6U]==1) {
     motor[claw] = 127;

   }else if (vexRT[Btn6D] ==1) {
     motor[claw] = -127;

   }else{
     motor[claw] = 0;

     }

   //mobile goal control
     if(vexRT[Btn7U]==1){
     motor[mogo_left]=127;
     motor[mogo_right]=127;

   }else if (vexRT[Btn7D]==1){
     motor[mogo_left] = -127;
     motor[mogo_right] = -127;
   }else{
     motor[mogo_left] = 0;
     motor[mogo_right] =0;
     }
   }
```

User Control (Drive)

-What connects the remote control to the robot is the vexRT function.

The drive consists of four motors. Frontleft is plugged into port 1; backleft is plugged into port 2; frontright is plugged into port 3; backright is plugged into port 4. Simply setting the powers of each of the ports to 127 however, will not cause the robot to move straight. This is caused by the fact that the left and right motors are mirror images of one another. This symmetry causes the rotating shafts of the motors to be facing in opposite directions. Ultimately, the motors rotate in opposite directions and cause the robot to spin, rather than move straight. In order to solve this, we must reverse both sides of the right motors in the pragma.

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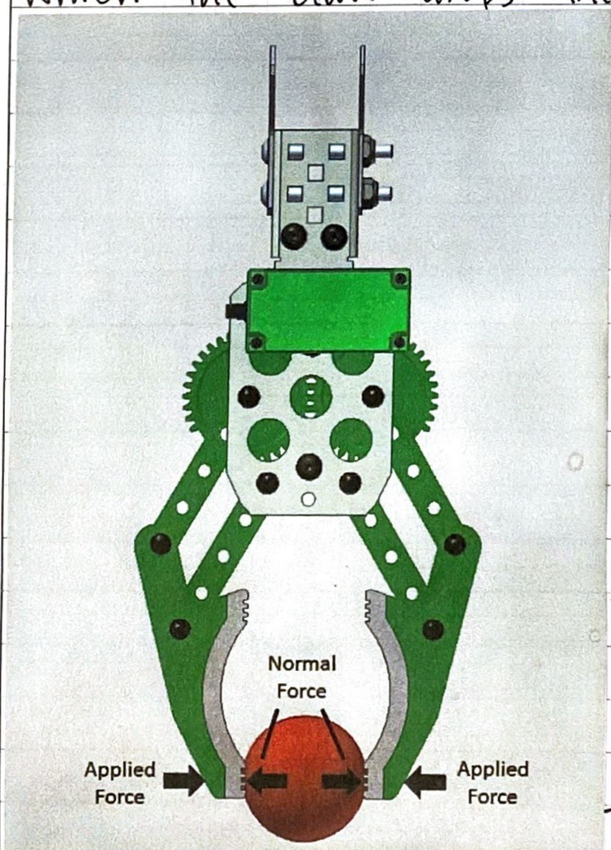
Claw Brainstorming 10/19/17

We tested the VEX claw and saw where the lift rests on the drive. We found that the claw is able to securely hold the yellow cone and pick it up to the opposite side of the robot. In this way, the claw would work most efficiently for the robot. The claw is one of the crucial parts of the robot for the reason that it picks up and grasps the yellow cones. What is important to note is that the chain bar lift will result in the claw to face in the same direction at all times. So, once the claw catches hold on the cone, it would be brought to the opposite side of the robot while the claw points in the same direction. This indicates that the mobile goal lift would have to be built appropriately and in regards to the position in which the claw drops the cone.




The vex claw is most efficent for our task

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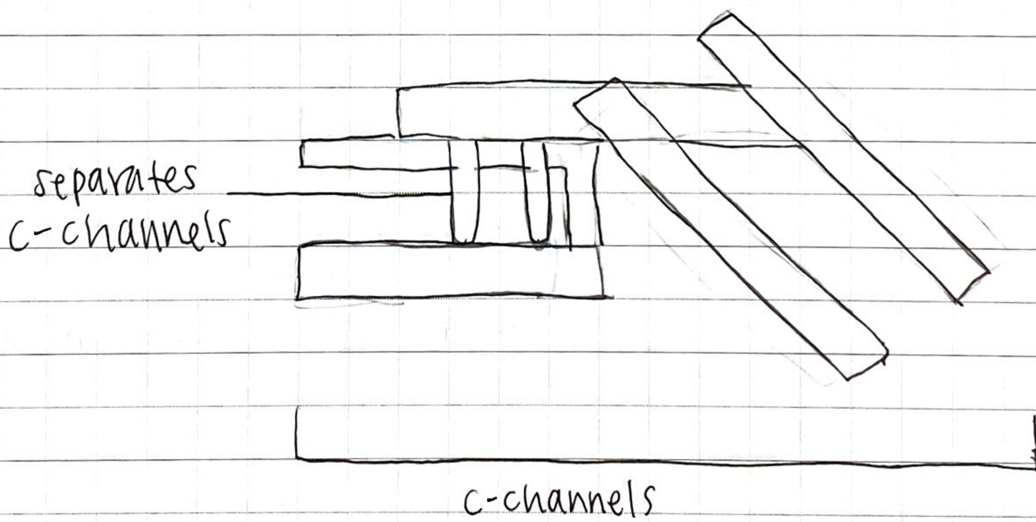
## Designing the Mobile Goal Lift 10/22/17

The mobile goal lift was designed so that it will be able to pick up and drop the mobile goals with ease. The mobile goals would slide into the lift and be brought into the center of the robot. Because the mobile goals are to be brought into the center of the robot, this will eliminate any possibility of it (the ~~cones o~~ mobile goal) and the cones from bumping into another object or robot, and toppling over. We also plan to make the mobile goal lift so that it is able to reach forward enough to drop the mobile goals into the zones of the competition. We plan to design the robot in this way because the robot would not have to move in as far in the zones to drop the mobile goals. Instead, it would only have to reach forward and drop the goals as opposed to transporting the entire body of the robot just to score. Therefore, we see this design of the mobile goal lift to be ~~the~~ more concise and precise in terms of movement as well as more quick.

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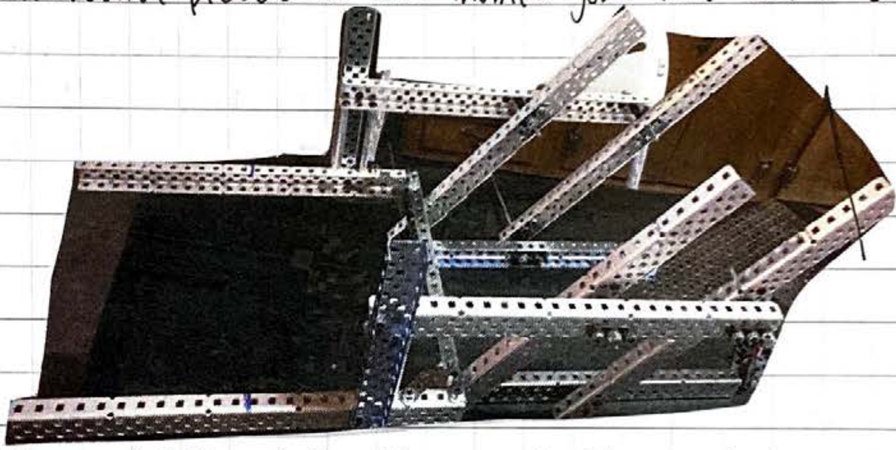
Building the Mobile Goal Lift 10/26/17

We utilized aluminum c-channels for the arm lift and the mobile goal lift. In order to meet and stay within the 18" requirement, we cut down the aluminum pieces of the mobile goal lift down 6.5 in.



Problem: The mobile goal lift points down, yet it must be level.
Solution: We added washers to the supports of the mobile goal lift

Problem: The mobile goal is not securely fit into the mobile goal lift, and there is a great possibility that the mobile goal would slip out.
Solution: By adding friction padding on the mobile goal lift, the mobile goal would not slip out and it would be secure.

Problem: The arms of the lift kept slamming down due to the heavy steel.
Solution: We replaced the steel with aluminum since it no longer tilts the robot.

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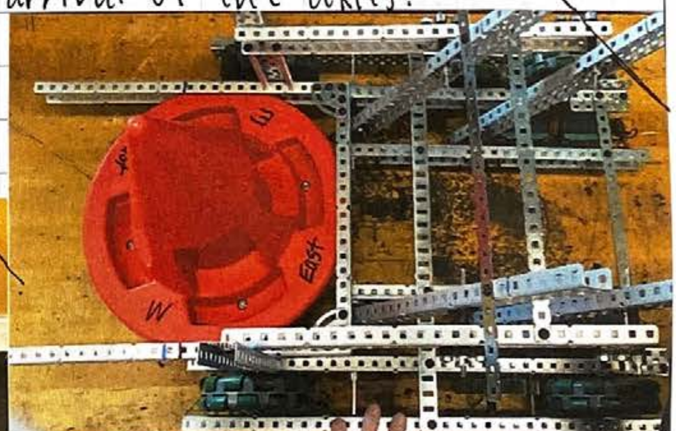
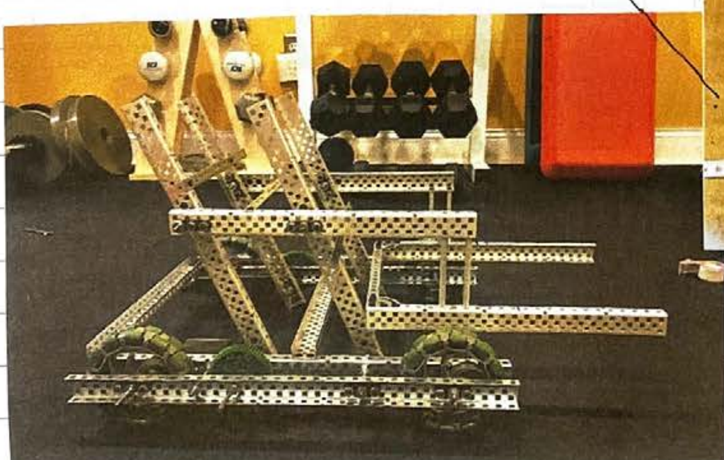
Attaching the Mobile Goal Lift 10/29/17

The mobile goal lift consists of 6.25" c-channels located in front of the mobile goal lift with an L-channel placed in the back of the lift. These structures ensure that the mobile goal is securely placed in the lift. Additionally, we added X-bracings within the lift, specifically between the C-channels to stabilize the mobile goal lift as a whole. It is important to maintain stability in the mobile goal lift because it allows us to have more control of the lift when the robot goes to pick up the yellow cones.

Problem: Axles were not able to reach all the way through the mobile goal lift as well as the drive.

Solution: New axles were purchased, but the overall process of building the robot and finishing it slowed down since we had to wait for the arrival of the axles.



Marked areas indicate places to cut.

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Programming the Mobile Goal Lift 11/7/17

```
task usercontrol()
{
#define Full_Power 127;
#define HALF_POWER 63;
#define STOP 0;
#define FL motor[frontleft]
#define FR motor[frontright]
#define BR motor[backright]
#define BL motor[backleft]
#define LIFT motor[armleft]

  while(true)
  {
    //joystick control:
    motor[frontleft] = vexRT[Ch3];
    motor[backleft] = vexRT[Ch3];
    motor[frontright] = vexRT[Ch2];
    motor[backright] = vexRT[Ch2];}


//lift control
if(vexRT[Btn5U]==1){
  motor[armleft]=127;
  motor[armright]=127;

}else if (vexRT[Btn5D]==1){
  motor[armleft] = -127;
  motor[armright] = -127;
}else{
  motor[armleft] = 0;
  motor[armright] =0;
```

```
//claw control
if(vexRT[Btn6U]==1) {
      motor[claw] = 127;

}else if (vexRT[Btn6D] ==1) {
      motor[claw] = -127;

}else{
      motor[claw] = 0;

      }

//mobile goal control
      if(vexRT[Btn7U]==1){
      motor[mogo_left]=127;
      motor[mogo_right]=127;

}else if (vexRT[Btn7D]==1){
      motor[mogo_left] = -127;
      motor[mogo_right] = -127;
}else{
      motor[mogo_left] = 0;
      motor[mogo_right] =0;
      };
}
   UserControlCodePlaceholderForTesting();
}
```

The code for the mobile goal lift imitates the code for the lift, as there is a left mobile goal motor (plugged into port 5) and a reversed right ~~mobile~~ mobile goal motor (plugged into port 6). Lines 366-368 tell the controller that when button 7u is pressed, both mobile goal motors will operate at full speed. Lines 370-372 program mobile goal lift motors to retract the mobile goal at full speed when button 7d is pressed, and lines 373-375 ensure that the mobile goal motors do not move unless the specific buttons are pressed.

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Programming the Lift 11/12/17

```
task usercontrol()
{

  while (true)
  {
      //joystick control:
            motor[frontleft] = vexRT[Ch3];
            motor[backleft] = vexRT[Ch3];
            motor[frontright] = vexRT[Ch2]
            motor[backright] = vexRT[Ch2];

            //lift control

            if(vexRT[Btn5U]==1){
                  motor[armleft]=100;
                  motor[armright]=100;

            }else if (vexRT[Btn5D]==1){
                  motor[armleft] = -100;
                  motor[armright] = -100;
            }else{
                  motor[armleft] = 0;
                  motor[armright] =0;
}
//claw control
if(vexRT[Btn6U]==1) {
      motor[claw] = 127;

}else if (vexRT[Btn6D] ==1) {
      motor[claw] = -127;

}else{
      motor[claw] = 0;

      }

//mobile goal control
      if(vexRT[Btn7U]==1){
      motor[mogo_left]=127;
      motor[mogo_right]=127;

}else if (vexRT[Btn7D]==1){
      motor[mogo_left] = -127;
      motor[mogo_right] = -127;
}else{
      motor[mogo_left] = 0;
      motor[mogo_right] =0;
      }
}
    UserControlCodePlaceholderForTesting()
  }
```

The robot has 2 motors on the chain bar lift: one on the right and one on the left. The left lift motor is plugged into port 7 and the right lift motor is plugged into port 8. The right lift motor is reversed to account for its mirrored position in respect to the left motor. Lines 341-343 tell the controller that when button 5u is pressed, both lift motors will operate at full speed. Lines 345-347 program the lift motors to retract at full speed when button 5d is pressed, and lines 348-350 ensure that the lift motors do not move unless the specific buttons are pressed.

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Programming the claw 11/16/17

```
task usercontrol()
{

  while (true)
  {
     //joystick control:
          motor[frontleft] = vexRT[Ch3]
          motor[backleft] = vexRT[Ch3];
          motor[frontright] = vexRT[Ch2
          motor[backright] = vexRT[Ch2]

          //lift control

          if(vexRT[Btn5U]==1){
               motor[armleft]=100;
               motor[armright]=100;

          }else if (vexRT[Btn5D]==1){
               motor[armleft] = -100;
               motor[armright] = -100,
          }else{
               motor[armleft] = 0;
               motor[armright] =0;
}
//claw control
if(vexRT[Btn6U]==1) {
     motor[claw] = 127;

}else if (vexRT[Btn6D] ==1) {
     motor[claw] = -127;

}else{
     motor[claw] = 0;

     }

//mobile goal control
     if(vexRT[Btn7U]==1){
     motor[mogo_left]=127;
     motor[mogo_right]=127;

}else if (vexRT[Btn7D]==1){
     motor[mogo_left] = -127;
     motor[mogo_right] = -127;
}else{
     motor[mogo_left] = 0;
     motor[mogo_right] =0;
     }
}
   UserControlCodePlaceholderForTesting();
   }
```

The claw has 1 motor plugged into port 10, which allows it to open and close. lines 354-355 tell the controller that when button 6u is pressed, the claw opens at full speed. Lines 357-358 programs the claw to close at full speed when button 6d is pressed, and lines 360-361 ensure that the claw does not move unless the specific buttons are pressed.

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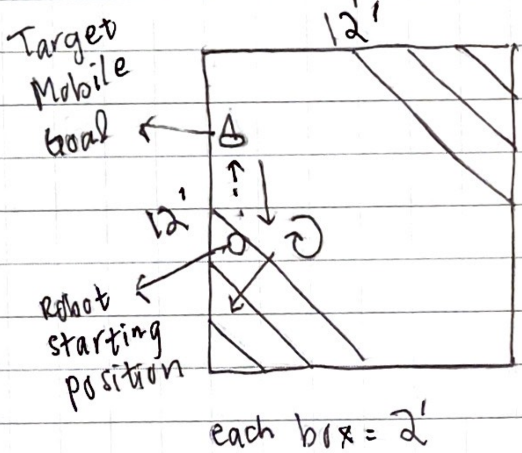
## Autonomous Strategy and Programming 11/21/17

As part of our first autonomous game strategy, we laid out our program so as to focus most on accuracy as well as efficiency. Specifically, our game goes to as follows:

1) The lift is raised from the front side to the back side.
2) The mobile goal lift comes out, getting ready to lift the mobile goal.
3) The robot proceeds to move around 3 ft. (actual measurements are based upon trial and error – see code).
4) After the robot moves up to the mobile goal, it scoops it up using the lift.
5) The robot, with the mobile goal, then travels straight backwards for around 2.5 ft. (actual measurements are based off of trial and error).
6) At the 2.5 ft. mark, the robot will complete a point turn.
7) The robot will continue to move forward and will drop the mobile goal in the 10-point zone.
8) End timed auton.




```
task autonomous()
{
 while(true)
      {

            //move lift
motor [armleft] = 127;
motor [armright] = 127;
wait1Msec(800);

motor [armleft] = 0;
motor [armright] = 0;
wait1Msec(100);

//move forawrd a lil bit while picking up the mobile goal
motor [mogo_left] = -127;
motor [mogo_right] = -127;
wait1Msec(1200);
```

Trial = Robot moves about 2 feet per second

$\frac{3ft}{x\,sec} = \frac{2ft}{1\,sec}$

To move 3ft, the robot takes 1.5 sec approximately.

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```
motor [mogo_left] = 0;
motor [mogo_right] = 0;
wait1Msec(50);

        //move forward 3ish ft
        motor[frontright]=127;
        motor[frontleft]=127;
        motor[backleft]=127;
        motor[backright]=127;
        wait1Msec(3000);

        motor[frontright]=0;
        motor[frontleft]=0;
        motor[backleft]=0;
        motor[backright]=0;
        wait1Msec(1000);


//bring mogo back in and rotate
motor [mogo_left] = 127;
motor [mogo_right] = 127;
wait1Msec(1000);

motor [mogo_left] = 0;
motor [mogo_right] = 0;
wait1Msec(100);

motor [frontleft] = -127;
motor [frontright] = -127;
motor [backleft] = -127;
motor [backright] = -127;
wait1Msec(2500);

motor [frontleft] = 0;
motor [frontright] = 0;
motor [backleft] = 0;
motor [backright] = 0;
wait1Msec(50);

//move forward 6ft
motor [frontleft] = 127;
motor [frontright] = 0;
motor [backleft] = 127;
motor [backright] = 0;
wait1Msec(2300);

motor [frontleft] = 0;
motor [frontright] = 0;
motor [backleft] = 0;
motor [backright] = 0;
wait1Msec(50);

motor [frontleft] = 127;
motor [frontright] = 127;
motor [backleft] = 127;
motor [backright] = 127;
wait1Msec(1000);

motor [frontleft] = 0;
motor [frontright] = 0;
motor [backleft] = 0;
motor [backright] = 0;
wait1Msec(100);

motor [mogo_left] = -127;
motor [mogo_right] = -127;
wait1Msec(2000);

motor [mogo_left] = 0;
motor [mogo_right] = 0;
wait1Msec(100);
  AutonomousCodePlaceholderForTesting();
}
}
```

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Autonomous Strategy and Programming (cntd.)

Trials

Date: 12/5/17

Round 1 - works Time: 14.33 s

Round 2 - unable to pick up mobile goal

Round 3 - works Time: 14.85 s

Round 4 - works Time: 14.52 s

Round 5 - unable to pick up mobile goal

Problem: When the arms of the lift moves back, it slams into the robot, causing the robot to be tilted in position. As a result, the robot is unable to pick up the mobile goal, since it is bump off the path to the mobile goal.

Solution: We made it so that the arms of the lift move for less time. Essentially, the motors go for less time.

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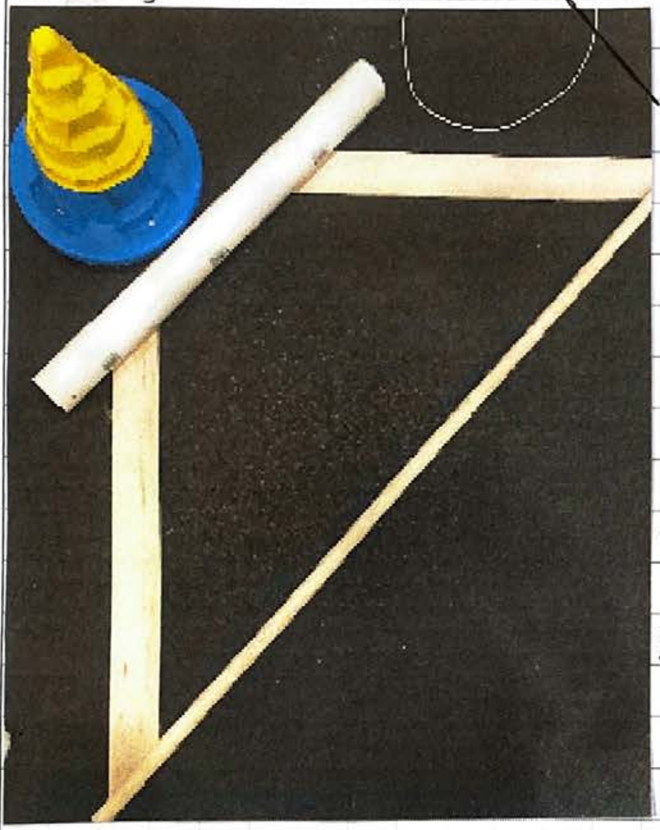
Driving 12/7/17



By setting up our own competition field and purchasing cones as well as mobile goals, we were able to practice driving the robot. We were also able to see if our robot was capable of ~~permo~~ performing the tasks we built it to do. This field was used to test out our autonomous field as well.

Problem: The mobile goal is sliding off.

Solution: We changed the L-channel in the back with a C-channel

Calculations: Trials of points earned in 1min. 45sec.:

| $\Sigma x = 456$ | Trial | # of Points | Trial | # of Points | → Mean: average of |
|---|---|---|---|---|---|
| $sx = 4.073$ | 1 | 16 | 11 | 24 | 22.8 points |
| $\sigma x = 3.970$ | 2 | 26 | 12 | 26 | → Relatively low |
| $\min(x) = 16$ | 3 | 24 | 13 | 22 | sample standard |
| $Q_1 = 18$ | 4 | 22 | 14 | 28 | deviation and population |
| $\text{med}(x) = 24$ | 5 | 26 | 15 | 22 | standard deviation — |
| $Q_3 = 26$ | 6 | 22 | 16 | 24 | allows us to be |
| $\max(x) = 28$ | 7 | 28 | 17 | 24 | confident about the |
| IQR 8 | 8 | 16 | 18 | 26 | # of points we can |
| | 9 | 18 | 19 | 16 | earn during competition. |
| | 10 | 18 | 20 | 28 | |

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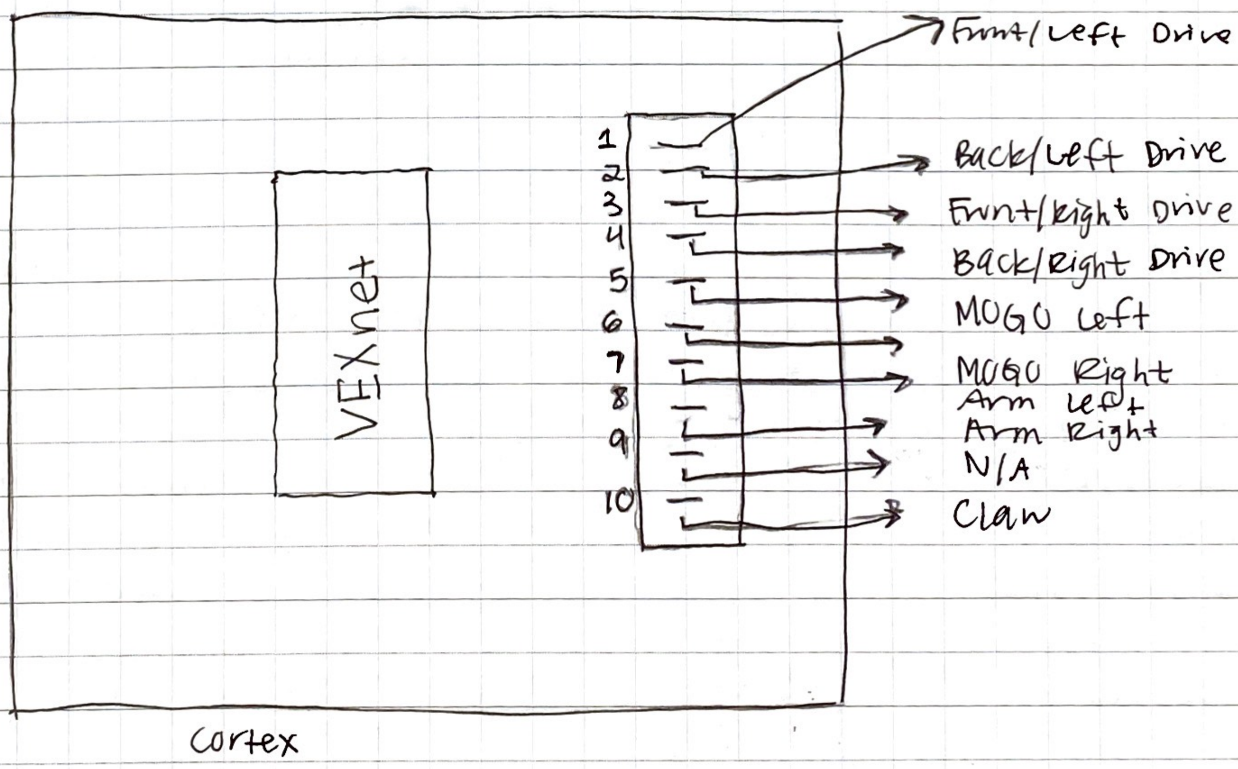
## Improvements 12/10/17

We were able to use 2 wire ports for the front left of the drive and the right lift. We used extension cables from the other motors in order to reach the cortex. When we put in the wires to the ports, the code did not match up with the ports. However, we quickly fixed that by changing the code to match the ports.

Problem: The wires got caught in the mobile goal lift and they were ripped out.

Solution: We cleaned up the wiring with zip ties and also put on wire clips to hold the wires together.

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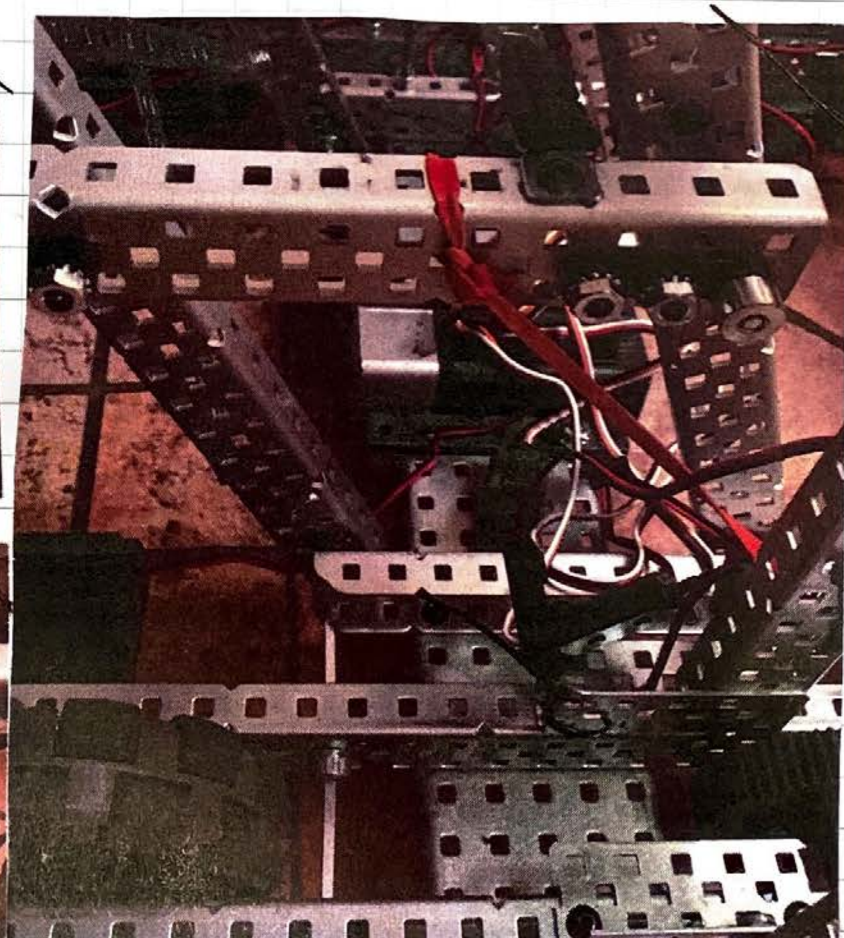
Reviewing our work 12/12/17

Today, we are reviewing the work we have done, making sure the robot fits all of the rules, and checking for any mistakes that may occur in the future. We added rubber bands and zip ties to the robot: the rubber bands would help the mobile goal lift to retract back once it reached forward to grab a mobile goal while the zip ties held wires together in an organized fashion. Additionally, we attached the license plate with one screw so that we will be able to quickly switch team colors during the competition.





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Night Before Competition 12/15/17

We changed out some hex nuts to lock nuts so that the vibrations don't turn them loose. The foam that prevented the lift from slamming had to be changed because it was damaged from holes. We conducted multiple test runs for autonomous game to make sure we were able to complete the tasks in the given time period.


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Competition Checklist 12/15/17

- ☑ 2 batteries (7.2V battery)
- ☑ Toolbox
- ☑ Gearbox
- ☑ Glasses (3)
- ☑ Joystick
- ☑ Friction padding
- ☑ Metal shaver
- ☑ Foam
- ☑ USB/Cortex cable
- ☑ Computer
- ☑ Robot

We want to be sure that we do not forget to bring any equipment or materials for our competition (especially since it is our first one!). It would be disheartening to realize that we forgot something once we get to the competition. This is because this disadvantage could be preventable and could ~~have~~ potentially be the reason why we do not fulfill our full potential. Thus, we double and triple check to make sure we have all materials prepared the night before the competition. Go team!

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Day of the Competition 12/16/17

The moment we arrived at Camden County Techical School, we were met with the competition field as well as the 23 other teams. After passing the size check-in, we went onto the skills challenge. We scored 5 points in programming and 14 points in drive on the first attempt. On the second attempt we scored a total of 17 points in drive, with a final drive score of 22 points. Next, we did an interview with the judges. We talked about building of the robot, programming, problems and solutions, and how our team came together through robotics. Our team was up for the first match of the competition. It was a bit rough due to the fact that we were unfamiliar with the cord that must be plugged in during autonomous and drive, and that it was our very first time on the field with other robots. Our autonomous worked 2 out of the 7 matches we competed in, but it worked when we needed it to work the most. We were also caught off guard when the teams we were working with told us to play defense since it was not an effective strategy to win a match. Additionally, we ~~made~~ were picked by Team Knights in their alliance for the qualification rounds. Unfortunately, we lost in the semifinals, but we received the Design Award for our notebook. Overall, this competition was very rewarding in that we gained a lot of experience.

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Reflection of Competition 12/16/17

The competition earlier today at Camden County Technical School shows us our strengths as well as our weaknesses in our robot and in our programming. To start off, we ended up making it into 9th place in qualification rounds. The skills challenges, interview processes, and the tournament style were all a learning experience for our team. We were picked for semi-finals; however, we lost during the elimination rounds. 2616Y was very content with the performance of the robot during the competition. Making it to semi-finals for our first competition ever showed us the potential of our team. During the awards ceremony, we were called up for the Design Award, which in turn qualified our team for the state-level competition! For future competitions, our goal is to modify and improve our robot until less errors are made, and to understand fully the game strategies to push ~~our~~ our team and robot to be the best it can be. By being able to compete at states, our team gained even more motivation and confidence to succeed and showcase our capabilities through our robot.

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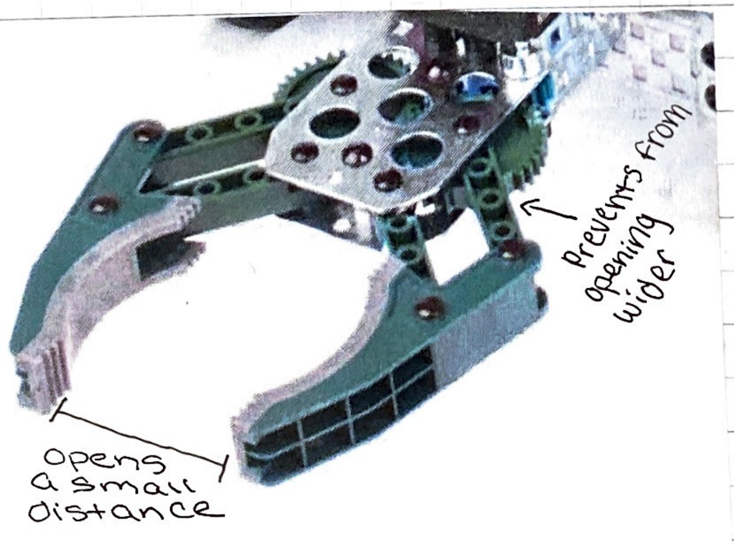
Problems during the competition (CCTS) 12/17/17

Problem 1: Strategy

Our initial strategy for In the Zone was to stack 3 yellow cones onto the mobile goals and drop them into the 20 point zone and later the 10 point zone. However, the time it took to get the mobile goals into the 20 point zone took too much time and resulted in the robot's wheels to get stuck in the zones. This was a problem because we could not score many points in the end.

Problem 2: Claw

For the first competition we utilized the vex claw. Although it functioned properly, it did not reach the expectations that we had for it. For example, the vex claw only opens to a certain extent, which was not enough to effectively pick up the cones. Thus, our driver had to be very precise when driving to not miss the cones or get a secure grip on the cone. On the other hand, the rubber inside the claw led to a strong grip on the cone when grasped correctly.

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Problems during the competition (cntd.)

Problem 3: Mobile Goal Lift

The mobile goal lift we designed had problems with precisely picking up the mobile goals. That is, the lift would either reach too high or bend too low. Also, if quick movements were needed in the match, the mobile goal would fall out when driving.

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Problem 4: Driving

With more practice in driving, we believe that our robot's performance will be greatly improved. Our driver could have used more practice in driving the robot so that she would be more comfortable with the robot on competition day. If she is comfortable driving the robot, she would be more at ease and feel less at a disadvantage compared to other teams who are more familiar and experienced with driving. For instance, our driver could prepare for future competitions by practicing picking up mobile goals without them falling out once the robot moves. In this way, our driver can feel confident and less nervous once the match begins.

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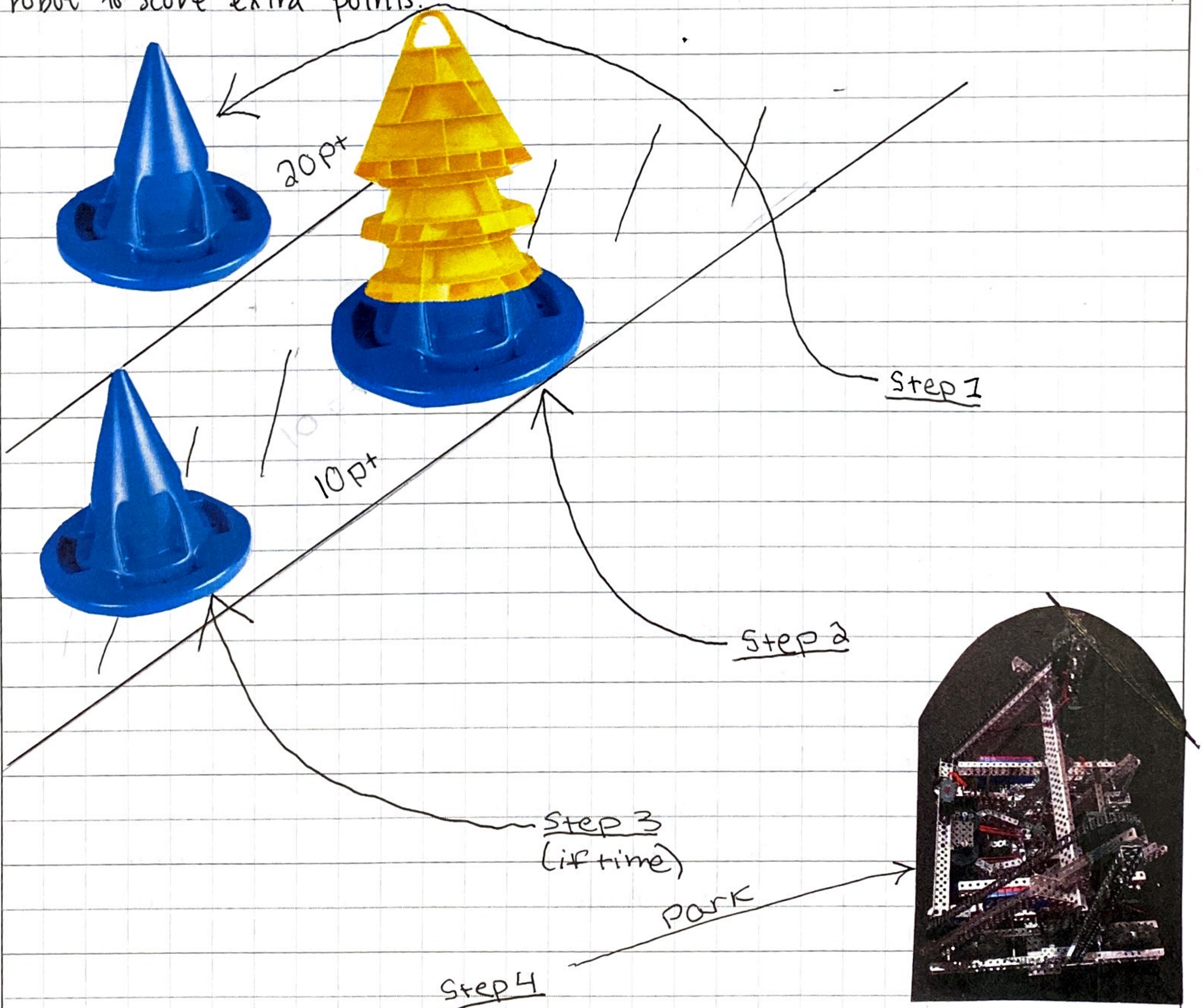
Solutions to competition problems and Brainstorming 12/19/17

Solution 1: Strategy

Our new strategy will include bringing the first mobile goal to the 20 point zone without stacking 3 cones on it. Then, we will get the second mobile goal and stack 3 cones on it so that we could potentially get the highest stack in the 10 point zone. Next, we will park the robot to score extra points.

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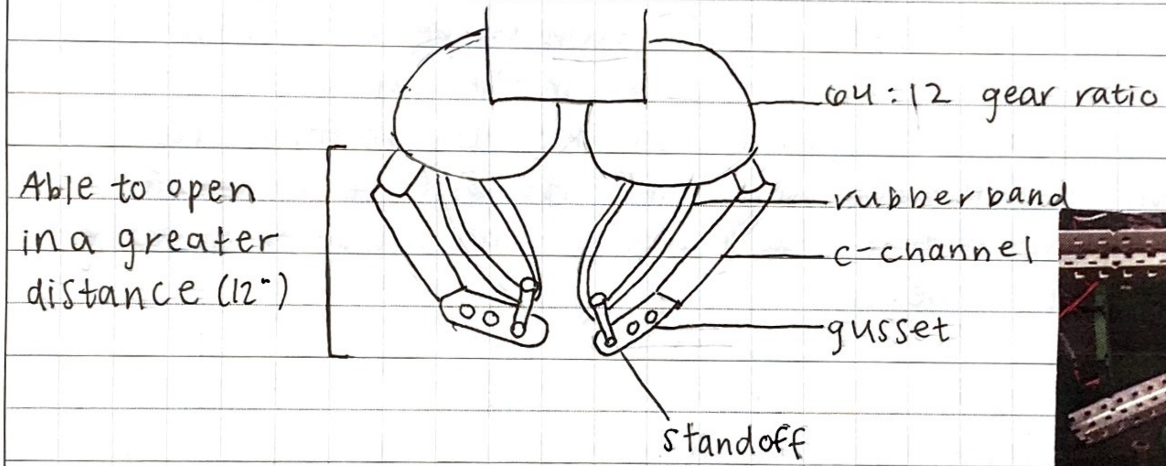
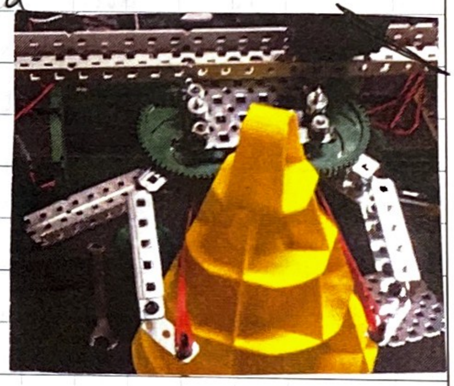
Solutions to competition Problems and Brainstorming (cntd.)

Solution 2: claw

We are going to construct our own claw that will be able to have a longer opening distance. This will enable the robot to have an easier access to the yellow cones as well as a greater chance at grabbing the cones successfully. With a better claw, we will be able to overcome the limitations of our current claw.



Solution 3: Mobile Goal Lift

In order to improve the ratio of the amount of times we are able to pick the lift up, we will utilize 1X3X1X6.5 c-channels instead of those measuring 1X2X1X6.5. We will also add more friction padding to the lift.

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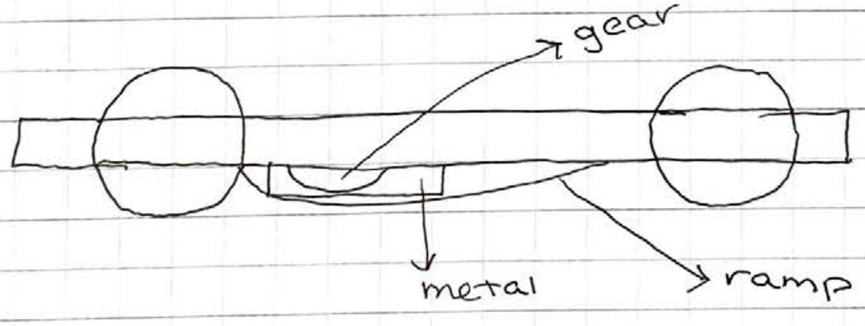
Solutions to Competition Problems and Brainstorming (Cntd.)

Solution 4: Driving

In order to improve in driving, we will have our driver practice frequently to prepare for the next competition. She will prepare by being able to smoothly move the mobile goal lift so that the mobile goal can smoothly slide into the lift. Our driver will also prepare by being able to keep the mobile goal in ~~p~~ position to prevent it from sliding out. Another aspect to improve upon is stacking cones without being too forceful. This caused the lift and claw to miss the mobile goal and the yellow cone was not stacked onto the mobile goal. This also sometimes resulted in the mobile goal to fall out due to the strong force upon it. By being familiar with all ~~parts~~ parts of the robot, driving will be much easier and less problems will arise.

Other Problems Encountered + Solutions

we noticed that our mobile goal lift gear was getting caught on the 10pt PVC pipe. In order to fix this we added a 1x2x1x5 peice of aluminum to cover the gear so that the gear would not hit the pipe, and then added a ramp so that the drive would have an easier time passing over the pipe.

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Mobile goal success analysis 1-11-17

| Trial # | works? |
|---|---|
| 1 | yes |
| 2 | yes |
| 3 | no |
| 4 | yes |
| 5 | no |
| 6 | yes |
| 7 | yes |
| 8 | yes |
| 9 | no |
| 10 | yes |

Today we have tested our mobile goal lift to see if the rate of success increased. We did 10 trials and it was successful 7 out of the ten times. Overall, it seems to be more stable and functions properly.

Confidence Interval for Mobile Goal Success

Our mobile goal lift had a 70% success rate. To see how certain we could be about this statistic, we constructed a 90% confidence interval. This allows us to be 90% confident that the success rate of the mobile goal lift will fall within the calculated interval. The formula for the confidence interval of a proportion is used.

$$\hat{p} \pm z\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

where $\hat{p}$ is the proposition of successes
where $z$ is the z-score
where $n$ is the sample size

$\hat{p} = \frac{7}{10} = 0.7$
$z = 1.645$
$n = 10$

$$0.7 \pm 1.645\sqrt{\frac{0.7(0.3)}{10}} = (0.46162, 0.93838)$$

1.645 has an area of 0.95 to the left, making it the z-score for a 90% confidence interval

With the conducted trials, we can be 90% confident that our mobile goal will succeed 46.162% to 93.838% of the time. We aim to narrow this interval in the future through redesign of the robot and/or claw.

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Competition checklist 1-13-18

- ☑ 2 batteries with chargers
- ☑ replacement wires
- ☑ Toolbox
- ☑ Gearbox
- ☑ glasses
- ☑ Joystick
- ☑ Friction padding
- ☑ Foam
- ☑ USB (cortex cable)
- ☑ computer
- ☑ robot

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Day of competition 1-14-18

we arrived at 7:15 after waking up at 5:15. We may have woken up too early but if it is for robotics... Y-Naught!

Problem: No open outlets to charge our batteries

Solution: Next time make a charging station... But for now, hope that another team lets you use theirs.

Problem: An opponent robot pushed our robot, which got a cone stuck beneath our robot.

Solution: We are considering adding friction wheels next time to prevent a future situation like this.

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Competition analysis 1-14-18

The competition at Ranney's School was far more competitive compared to our first competition. We ended the competition in 11th place and improved in the skills challenge: 10 points in programming and 32 points in driving. We also improved in our driving skills overall. That is, our driver demonstrated more dexterity in controlling the robot. However, after seeing the impressive robots today, we decided to change our robot's design. The reason for this is that we want to be able to compete against other robots that are advanced, so we can face them at the same level of design and structure. One problem that we faced today was that a robot pushed our robot, causing a cone to get caught underneath the robot. As a result, our robot couldn't perform well during autonomous period, and ultimately the drive period. Throughout the entire competition, our autonomous performance had more failures then success, specifically 1 out of 6 matches. We also played on defense more than we played on offense, which we found to be effective. We did this by pushing other opponents' robots, preventing them from scoring a lot of points. From this competition, we learned that our current design will not bring our team to higher competition levels due to our need to improve on spaeing and stability in the structure of our robot. We must test our skills and knowledge to generate a successful robot. We also must challenge ourselves and each other to go beyond what we already know, and explore our options and possibilities for our new robot.

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Transformation Process 1/18/18

Drive and Mobile Goal

Figure 1:

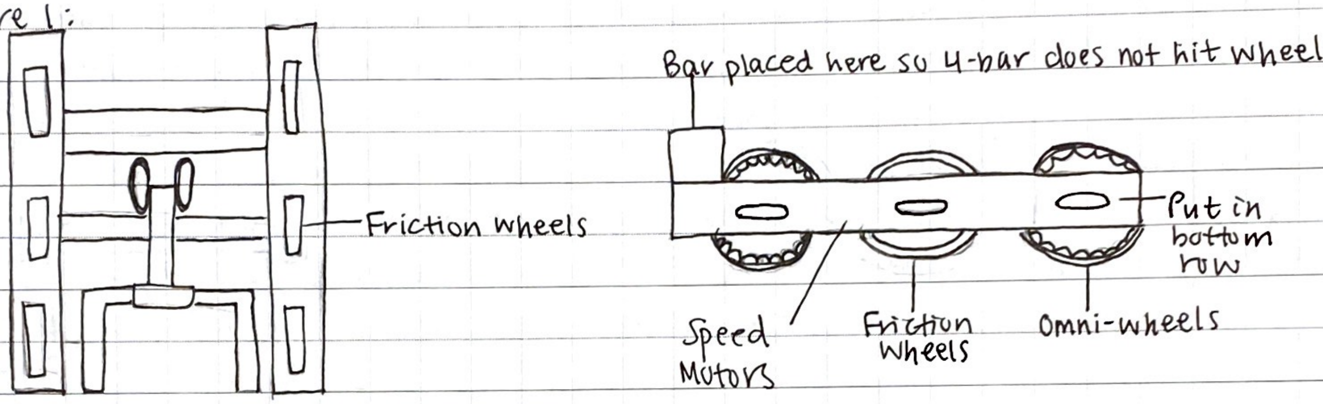
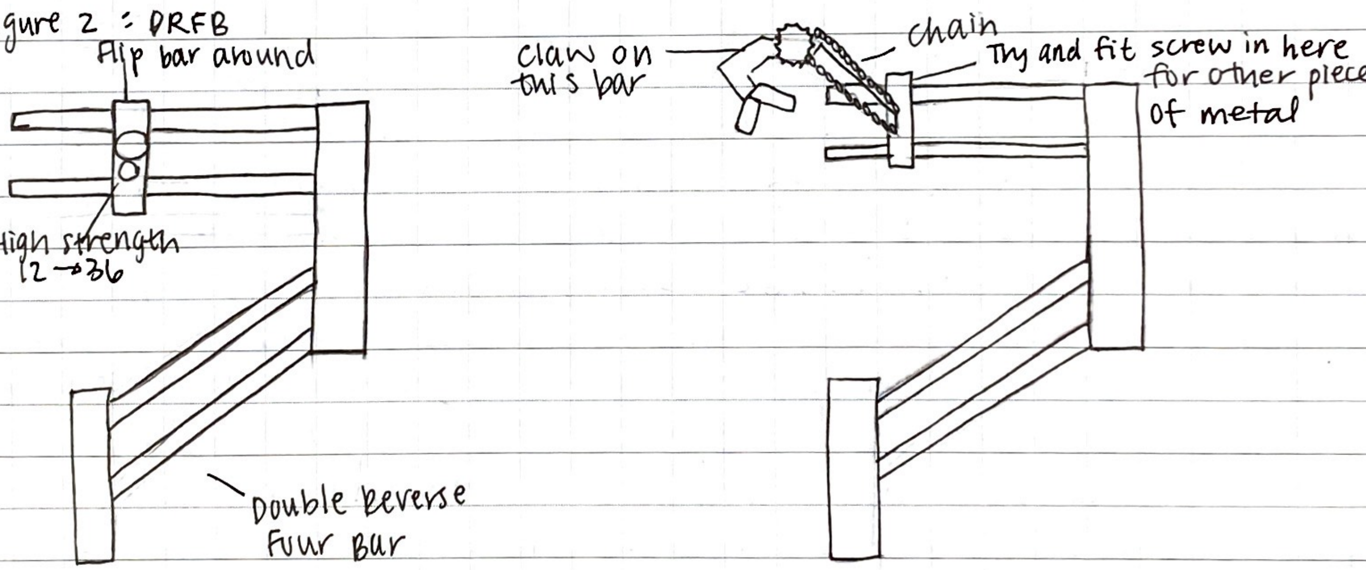



Figure 2: DRFB




*Chain keeps intake parallel

Friction wheels

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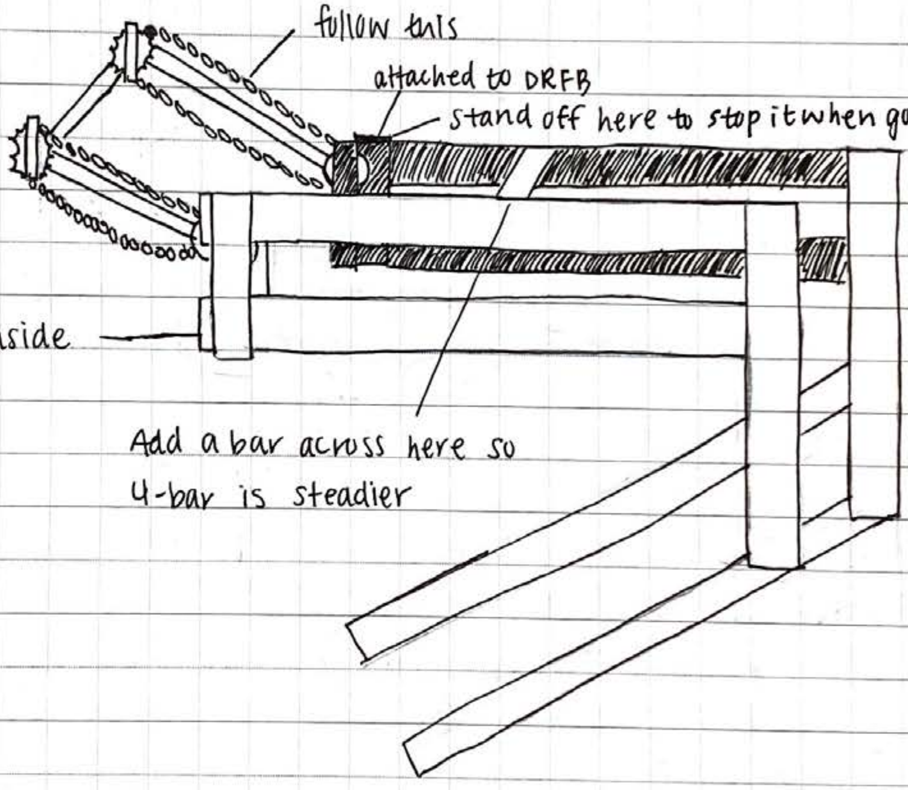
Figure 3: Chain Bar Lift Attached to DRFB




We chose this drive design because the omni-wheels will enable the robot to move in and out of the 10 point zone. We chose the DRFB so that we can reach higher heights to stack more cones and reach stationary goals. The chain bar lift was chosen because it maintains parallel structure for added stability.

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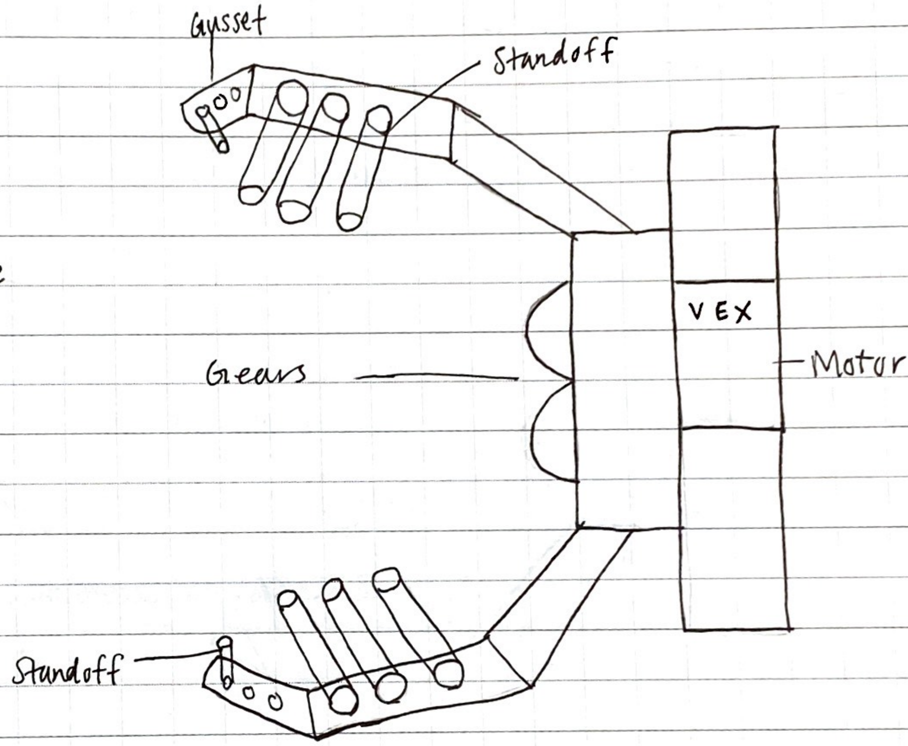
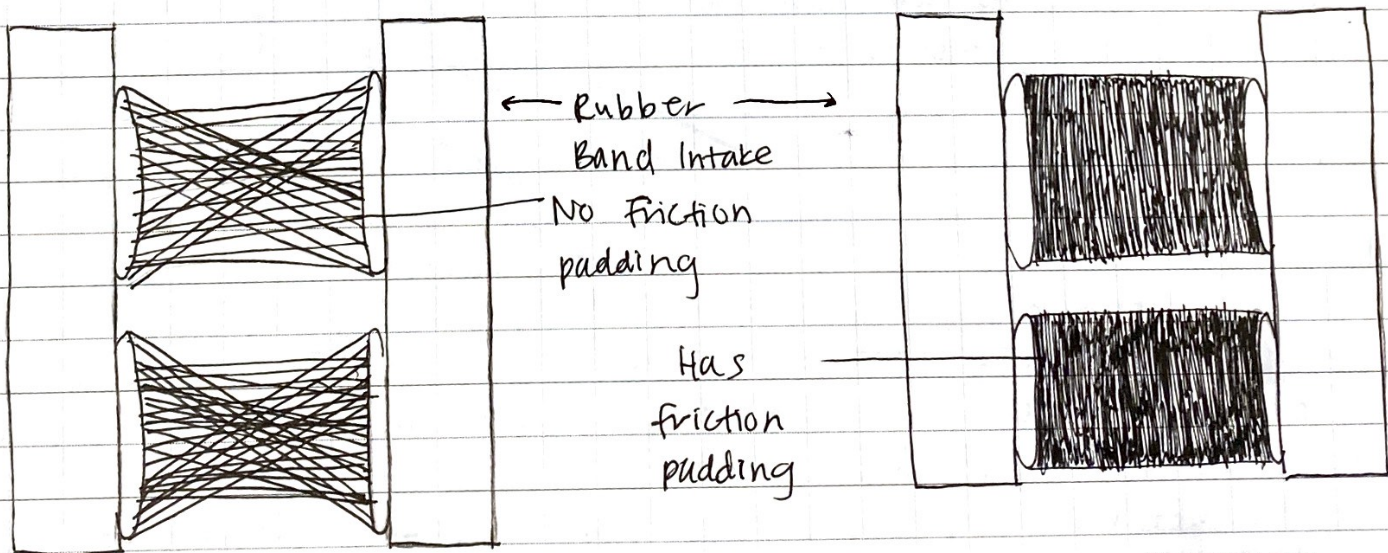
Intake Ideas for Cones :




Claw intake

This claw will allow us to be able to utilize an autonomous stacker. Thus, we chose this intake for cones. The claw can also open in larger distances compared to our previous claw.

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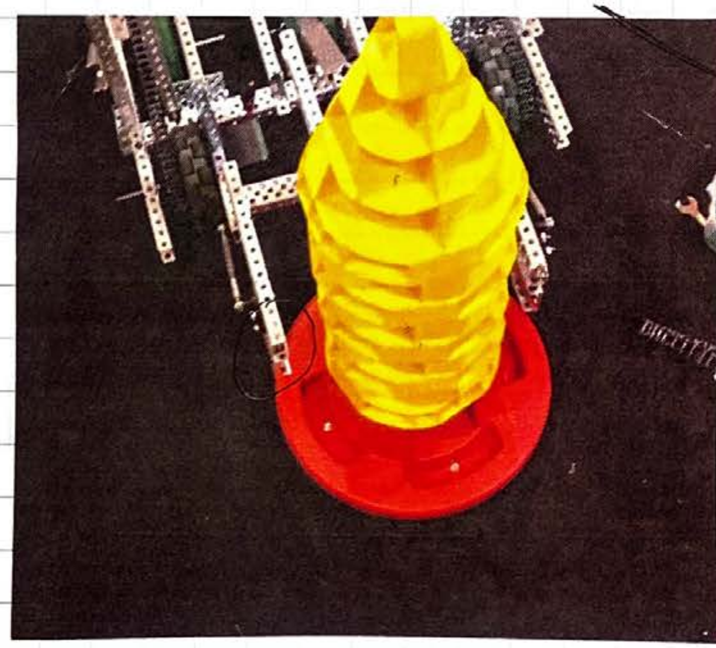
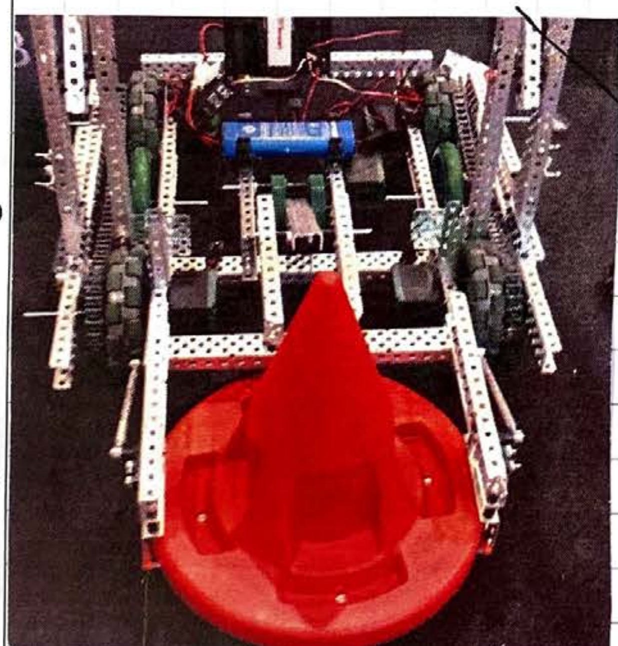
Problems with New Design 1/23/18 - 1/25/18

1.Mobile goal lift is too high and cannot pick up the mobile goal.

Solution: Take off standoff from base to let the mobile goal lift reach low enough to pick up mobile goal.



In this picture, we see that → the mobile goal lift is too high up to reach down to pick up and load the mobile goal.



→ can pick up mobile goal when stand off is taken off

As a result, the robot has no problem reaching down to pick up the mobile goal with its mobile goal lift. We see that the mobile goal is securely in the realms of the mobile goal lift. This is important since the mobile goals are key to the potential points we score in competitions.

Here, we added rubber bands to increase friction when loading the mobile goal.

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2. Mobile goal lift cannot pick up heavy weights. That is, when the yellow cones are stacked on top of the mobile goal, the mobile goal lift was unable to lift it up.

Solution: Use 2 motors to strengthen mobile goal lift.

3. With 2 motors, the lift will not go up, but it does go down smoothly.

Solution: Fix rubber banding on the lift. Make sure to mirror the banding on both sides.

4. The left lift motor is not functionning. We do not know if it is a motor problem or wiring problem. It could also be a programming problem or something with the motor controller.

Solution: Reverse the right lift motor.

5. Motor control for chain lift on the left side cannot function.

Solution: Switch out motor control wire.

6. Former solution to problem #2 could have been improved. We want to be more efficient with one motor.

Solution: Decrease torque of mobile goal lift in order to use one motor.

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Torque 1/25/18

We can calculate the torque required to lift the cone by using the formula Torque = (Force) x (Distance). Since the cone is 0.26 pounds, which converts to 1.156538 Newtons and the length of the chain bar is 10 inches, which converts to 0.254 meters, then

Torque = (Force) x (Distance)

Torque = (0.254m) x (1.156538 Newtons) = 0.293761 Newton-Meter

This means that the torque required to keep the object stationary is 0.293761 Newtons-Meters. In order to move it upwards, the robot needs to apply more torque than 0.293761 Newton-Meters to overcome gravity. The more torque the robot has, the more force it exerts on the object, the greater the acceleration on the object, and the faster the arm will lift it up.

Arm Load calculations / Motors 1/28/18

Stall torque (N-m): The amount of load placed on a motor that will cause it to stop moving.

Free Speed (RPM): The maximum rotational speed a motor will run at when it is under no load.

Stall current (Amp): The amount of current a motor will draw when it is Stalled.

Free Current (Amp): The ~~current~~ amount of current a motor will draw when it is under no load.

Motors have limits. At some point, the power will be too much for the motor's electrical windings to handle, and it will fail. Specifically, the maximum weight the robot can hold stationary occurs at the stall torque of the motor.

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## Arm Load Calculations/Motors (cntd.)

VEX 2-Wire Motor 393 (Single Motor)

| | Default | High Speed |
|---|---|---|
| Free Speed | 100 RPM | 160 RPM |
| Stall Torque | 1.67 N-m | 1.04 N-m |
| Stall Current | 4.8 Amps | 4.8 Amps |
| Free Current | 0.37 Amps | 0.37 Amps |

Torque = Force x Distance

$$\text{Force} = \frac{\text{Torque}}{\text{Distance}}$$

Stall torque = 1.67 N-m
Chain bar = 10 inches
10 inches = 0.254 m

$$\text{Force} = \frac{1.67\ \text{N-m}}{0.254\ \text{m}}$$

Force = 6.575 Newtons

This means the arm (if only one motor is used) can hold up to 6.575 Newtons at motor stall (stationary). Any more and the arm will drop.

Torque Load = Force x Distance
Yellow cone = 0.26 lbs
0.26 lbs = 0.117934 kg
Weight of object = mass of object x acceleration of gravity
1.1558 N = 0.117934 (9.8)
Torque Load = (1.1558 N)(0.254 meters)
Torque Load = 0.2936 N-m

The answer we obtained shows that one motor will suffice to sustain the torque load of one yellow cone. Also, since the game requires that the robot can only place one yellow cone at a time, we do not need to worry about using multiple motors.

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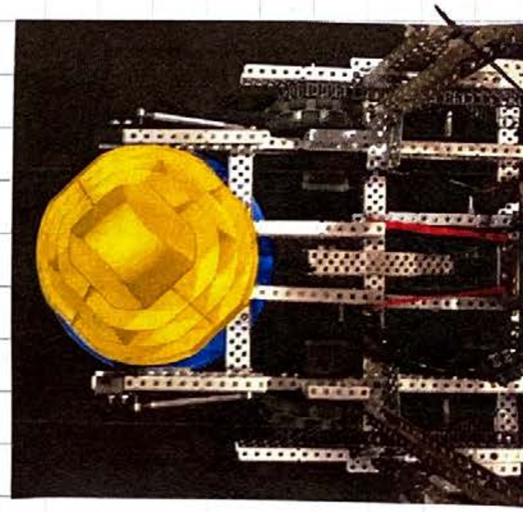
## Mobile Goal Lift: Calculations 1/28/18



Mobile Goal Lift length = 10 inches

1 meter = 39.37 inches

$10 \text{ in.} \times \frac{1 \text{ m}}{39.37 \text{ in}} = 0.254 \text{ m}$

Torque = Force x Distance

$\text{Force} = \frac{\text{Torque}}{\text{Distance}}$

$\text{Force} = \frac{1.67 \text{ N-m}}{0.254 \text{ m}} \rightarrow \text{Force} = 6.575 \text{ N}$

This means that the mobile goal lift (if only one VEX 2-wire Motor is used) can hold up to 6.575 N at motor stall (stationary position). Any more and the lift will droop down.

## Gear Train Design: Calculations 1/28/18

Circumference = diameter x $\pi$

C = 12.566 cm

$12.566 \text{ cm} \times \frac{10 \text{ mm}}{1 \text{ cm}} = 125.664 \text{ mm}$

The robot moves 125.664 mm per 1 wheel revolution. The wheel is moving at 100 revolutions per minute, or 100 revolutions per 60 seconds.

$\frac{125.664 \text{ mm}}{1 \text{ revolution}} \times \frac{100 \text{ revolutions}}{60 \text{ seconds}} = \frac{209.4395 \text{ mm}}{1 \text{ sec}}$

So, the robot moves 209.4395 mm/sec. The desired free speed is 900 mm/sec, what gear reduction is required?

$\frac{900 \text{ mm}}{1 \text{ sec}} \times \frac{1 \text{ revolution}}{125.664 \text{ mm}} = \frac{7.162 \text{ revolutions}}{1 \text{ sec}} \times \frac{60 \text{ sec}}{1 \text{ minute}} = \frac{429.717 \text{ revolutions}}{1 \text{ minute}}$

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Gear Train Design: Calculations (cntd.)

Input speed = 100 RPM → How fast the motor spins

Gear reduction required = Input speed / Output speed

Gear reduction required = $\frac{100 \text{ RPM}}{429.717 \text{ RPM}} = 0.2327$

We must use a gear reduction of 0.2327 or less to achieve a top speed of greater than 900 mm/second.

What is our highest speed at the moment based off of our current gear ratios?

X = highest capable speed

$$\frac{X \text{ mm}}{1 \text{ sec}} \times \frac{1 \text{ rev.}}{125.664 \text{ mm}} = \frac{X}{125.664} \text{ rev/sec}$$

$$\frac{X/125.664}{1 \text{ sec}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 0.47746X \text{ rev/min}$$

Gear reduction = $\frac{1}{7} = 0.1429$

$$0.1429 = \frac{100 \text{ RPM}}{0.47746X \text{ RPM}}$$

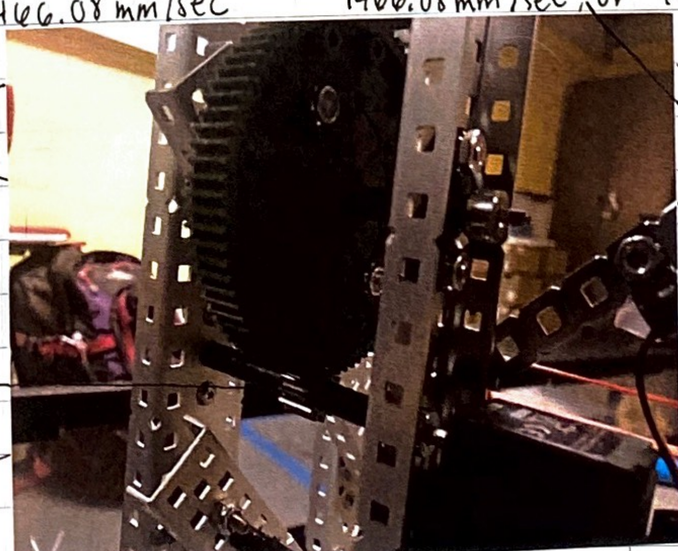
$$0.06821X = 100$$

$$X = 1466.08 \text{ mm/sec}$$

Using our current gear ratio of 1:7, the maximum speed that the VEX 2-Wire Motor 393 can reach is 1466.08 mm/sec, or 4.80997 ft/sec.

l.K

l.K



Here, we see the 1:7 gear ratio on the lift.

l.K.

l.K

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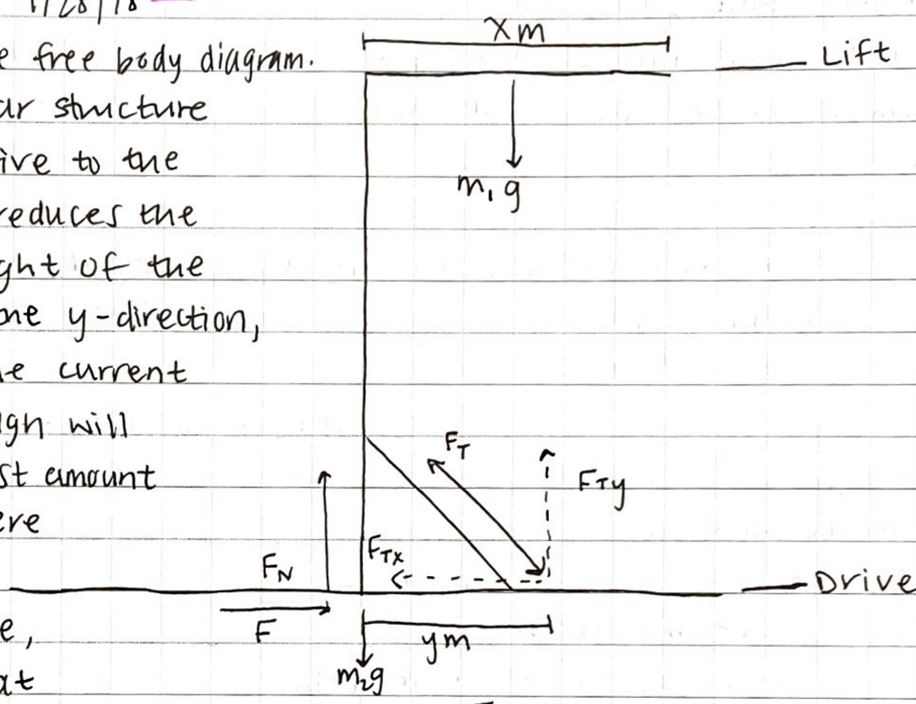
Free Body Diagram 1/28/18

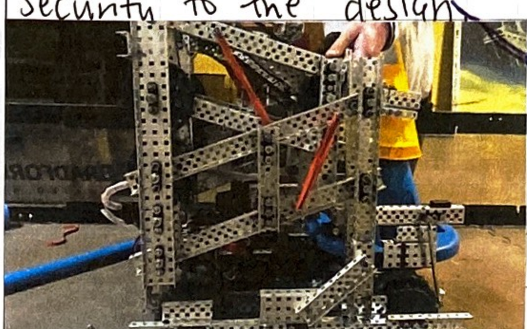
To the right shows the free body diagram. Since the triangular structure connecting the drive to the base of the lift reduces the force of the weight of the lift exerted in the y-direction, we know that the current architectural design will provide the greatest amount of stability. If there was not a triangular structure, the normal force at the point where the base of the lift connects to the



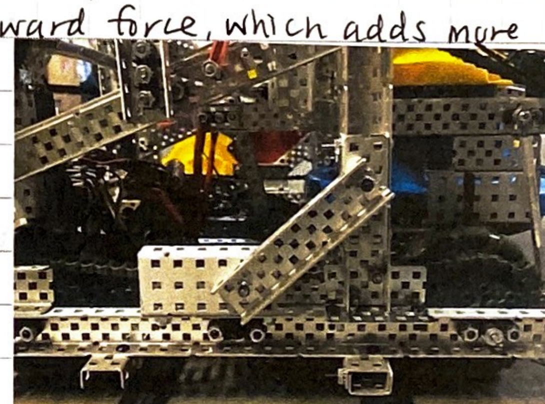

$$\sum F_x : F_{Tx} = F$$

$$\sum F_y : m_2 g + m_1 g = F_{Ty} + F_N$$

drive would have to be much greater because it has to equal the total weight force of the lift. By adding this short c-channel diagonally to create a triangle, a tension force with a component force in the y-axis direction helps to bear some of the weight force from the lift, thus evenly distributing the force better throughout the drive of the robot, creating structural stability. This structure also provides a tension force with a x-component force acting against the forward force, which adds more security to the design.



Note the triangular structure placed on drive, connecting the lift, for more stability.



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More Problems and Solutions 1/29/18

1. The friction wheels limited the space available for the chain between the wheels as well as our triangle that provides stabilization for our robot.

Solution: We removed the friction wheels since there was no room for the chain or triangle. We decided that stability takes precedence over having friction.

2. The auto stacker during driving is creating a cracking noise when it retracts back.

Solution: We made the chain bar go over slower and made the motor go slower and for less time. In other words, gravity would drag it down less forcefully.

3. The robot is not fast enough to go up and down when picking up cones.

Solution: Make the chain bar go down faster for speed.

4. In the autonomous period, our robot, which runs on a timed auton, repeatedly crashes into the stationary goal and turns too much when going towards the 10 point zone.

Solution: Change the amount of time of rotation and make the wheels rotate in opposite directions.

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5. When stacking the 6th cone, the chain bar hits the cone when going down and knocks down the stack on the mobile goal.

Solution: We moved the stop code for the double reverse four bar moving up after the code for the chain bar moving back. Thus, both will move at the same time. We also increased the time that the chain bar moved in order to precisely stack the cone.

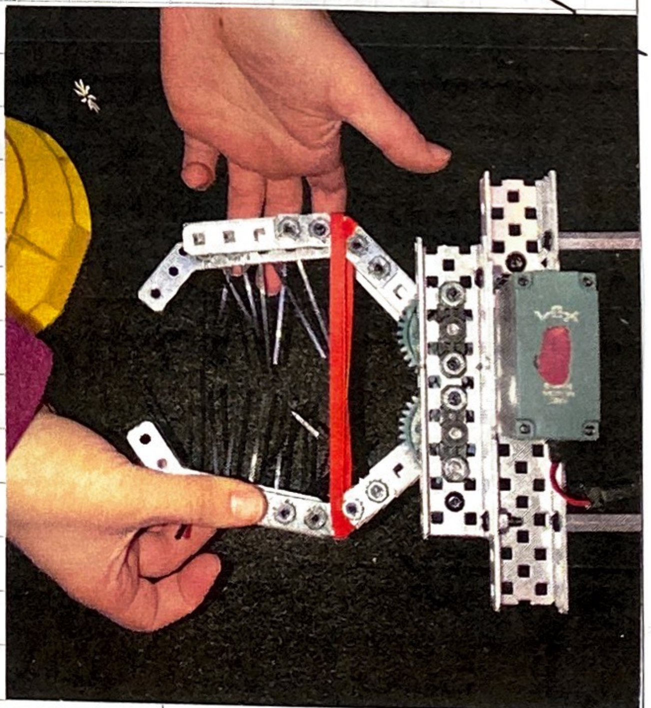
6. The claw cannot effectively pick up the yellow cones. We want the claw to be able to pick up the yellow cones with little to no error or failure and with ease.

Solution: We added 2 rubber bands to the middle of the claw to allow it to have a firmer grasp on the cone. We also added zip tides on the bottom c-channel for a secure grasp.

<u>Confidence Interval for Claw Picking up Cones</u> 1/31/18

Before fixing the claw, we tested the ability of our claw to successfully pick up the cone and contain the cone after the lift and chain bar move with it. In 30 trials our claw was able to carry out this task successfully 11 times. See following page for calculations.

On the right, we see our new and improved design of our claw (the outcome of the solution to problem #6). →



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The formula for the confidence interval of a proportion is used, as the formula conditions are met (Random, Normal, & Independent)

$$\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

$\hat{p} = \frac{11}{30} \rightarrow$ proportion of successes

$n = 30 \rightarrow$ # of trials

$z \approx 1.645 \rightarrow$ z-score w/ 0.95 area to the left

$= (0.22195, 0.511383)$

↳ we can be 90% confident that our claw will successfully pick up the cone, 22.20% to 51.14% of the time. Due to the wide interval & likelihood of low success rates, we redesigned the claw to efficiently pick up cones. (See Figure 2)

## Significance of Claw Redesign

After redesigning our claw, it successfully picked up the cone 29 out of 30 trials. We performed a 2 proportion z-test to examine the significance + effectivity of the claw redesign. The null hypothesis ($H_0$) states that there is no significance in the difference b/w the two proportions, and that any observed difference is due to experimental error. The alternative hypothesis ($H_a$) would indicate that the redesign caused significant improvement.

$H_0: \hat{p}_1 = \hat{p}_2$ and $H_a: \hat{p}_1 < \hat{p}_2$, where $\hat{p}_1 = \frac{11}{30} \rightarrow$ proportion of success w/ old claw

where $\hat{p}_2 = \frac{29}{30} \rightarrow$ proportion of success w/ new claw

Formula:

$$\frac{(\hat{p}_1 - \hat{p}_2) - 0}{\sqrt{\frac{\hat{p}_c(1-\hat{p}_c)}{n_1} + \frac{\hat{p}_c(1-\hat{p}_c)}{n_2}}} = z$$

where $z$ is the z statistic

where $\hat{p}_c = \frac{11+29}{30+30} \rightarrow \frac{\text{total success}}{\text{total trials}} \rightarrow$ combined proportion

↳ $z = -4.923 \rightarrow$ # of standard deviations from $\hat{p}_c$

The p-value is the probability of getting a z-statistic of this size in the direction specified by $H_a$

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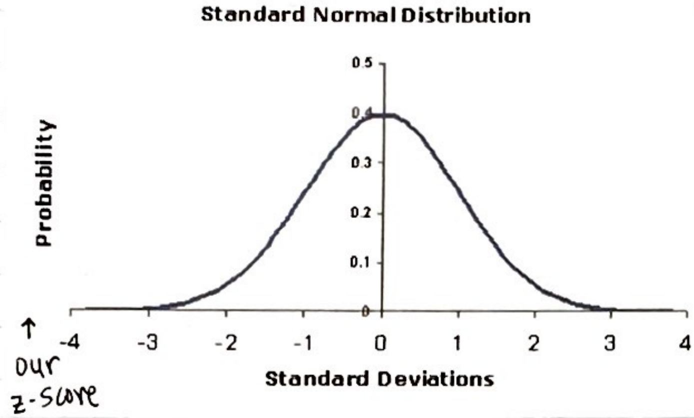
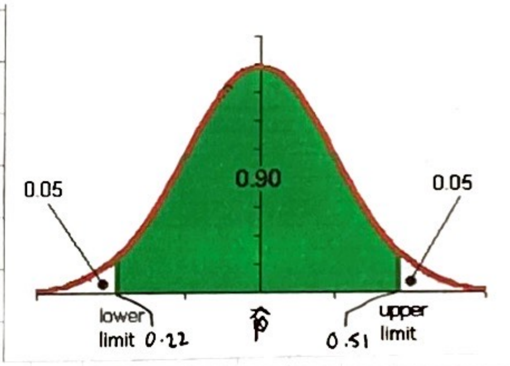
Figure 1




↑ our z-score

The normal distribution has an area of 1 under the curve. The p-value for the $H_a: \hat{p}_1 < \hat{p}_2$ is the area to the left of the z-score on the normal distribution.
There is very little area in this region → the p-value was calculated to be $4.13 \times 10^{-7}$, showing that the probability of our data occuring due to chance is $4.13 \times 10^{-5}$ % → Shows that our claw redesign is highly significant → a very effective redesign

Figure 2




The normal distribution graph is also used to calculate the original confidence interval of the proportion. The area of 0.90 under the curve b/w 0.22195 and 0.511383 allows us to be 90% confident about our calculated interval.

Trials of Points earned in 1 min 45 sec

| trial | points |
|---|---|
| 1 | 32 |
| 2 | 21 |
| 3 | 18 |
| 4 | 28 |
| 5 | 25 |
| 6 | 30 |
| 7 | 34 |
| 8 | 38 |
| 9 | 30 |
| 10 | 28 |

$\bar{X} = 28.4$ points
$\Sigma_x = 284$
$S_x = 5.929$
$\sigma_x = 5.625$
$n = 10$
Min = 18 $Q_3 = 32$
$Q_1 = 25$ Max = 38
Med. = 29 IQR = 7

Our standard deviation under 6-points allows us to feel confident about our performance in the competition. The trials also show a significant 5.6 point inc. from trials of our previous robot ($p < 0.01$)

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Autonomous Programming 2/1/18

```
task autonomous()
{
 while(true)
      {//move lift up
motor [drfleft] = -127;
motor [drfright] = -127;
waitlMsec(1500);

motor [drfleft] = 0;
motor [drfright] = 0;
waitlMsec(100);


//move forawrd a lil bit while picking up the mobile goal
motor [mogo] = 127;
waitlMsec(1000);

motor [mogo] = 0;
waitlMsec(50);

      //move forward 3ish ft
      motor[frontright]=127;
      motor[leftdrive]=127;
      motor[backright]=127;
      waitlMsec(1450);

      motor[frontright]=0;
      motor[leftdrive]=0;
      motor[backright]=0;
      waitlMsec(400);
 //bring mogo back in
 motor [mogo] = -127;
 waitlMsec(1000);

 motor [mogo] = 0;
 waitlMsec(100);

 //move lift back down
 motor [drfleft] = 127;
 motor [drfright] = 127;
 waitlMsec(950);

 motor [drfleft] = 0;
 motor [drfright] = 0;
 waitlMsec(100);

 //open claw
 motor [claw] = -127;
 waitlMsec(200);

 motor [claw] = 0;
 waitlMsec(50);

      //lift moves back up
motor[drfright] = -127;
motor[drfleft] = -127;
waitlMsec(400);

motor[drfright] = 0;
motor[drfleft] = 0;
waitlMsec(50);

//chain moves back over
motor[chainleft] = -85;
motor[chainright] = -85;
waitlMsec(300);

motor[chainleft] = 0;
motor[chainright] =0;
waitlMsec(100);

//lift moves down
motor[drfright] = 127;
motor[drfleft] = 127;
waitlMsec(650);

motor[drfright] = 0;
motor[drfleft] = 0;
waitlMsec(50);
```

```
      //claw closes
motor [claw] = 127;
waitlMsec(200);

motor[claw] = 0;
waitlMsec(50);

//lift moves up
motor[drfright] = -127;
motor[drfleft] = -127;
waitlMsec(400);

motor[drfright] = 0;
motor[drfleft] = 0;
waitlMsec(50);

//chain moves over
motor[chainleft] = 100;
motor[chainright] =100;
waitlMsec(700);

motor[chainleft] = 0;
motor[chainright] =0;
waitlMsec(50);

//lift moves back down
motor[drfright] = 127;
motor[drfleft] = 127;
waitlMsec(200);

motor[drfright] = 0;
motor[drfleft] = 0;
waitlMsec(50);
      //claw opens
      motor[claw] = -127;
      waitlMsec(200);

      motor[claw] = 0;
      waitlMsec(100);

 //move back
 motor [leftdrive] = -127;
 motor [frontright] = -127;
 motor [backright] = -127;
 waitlMsec(1600);

 motor [leftdrive] = 0;
 motor [frontright] = 0;
 motor [backright] = 0;
 waitlMsec(100);

 //turn
 motor [leftdrive] = -127;
 motor [frontright] = 127;
 motor [backright] = 127;
 waitlMsec(500);

 motor [leftdrive] = 0;
 motor [frontright] = 0;
 motor [backright] = 0;
 waitlMsec(100);

 //move forward
motor [leftdrive] = 127;
motor [frontright] = 127;
motor [backright] = 127;
waitlMsec(250);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
waitlMsec(100);

//turn
motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
waitlMsec(500);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
waitlMsec(100);

//move forward
motor [leftdrive] = 127;
motor [frontright] = 127;
motor [backright] = 127;
waitlMsec(250);

motor [leftdrive] = 0;
motor [frontright] = 0;
```

```
motor [backright] = 0;
waitlMsec(100);

//move lift back up
motor [drfleft] = -127;
motor [drfright] = -127;
waitlMsec(650);

motor [drfleft] = 0;
motor [drfright] = 0;
waitlMsec(100);

//put mogo back out
motor [mogo] = 127;
waitlMsec(1000);

motor [mogo] = 0;
waitlMsec(50);

//move back
motor [leftdrive] = -127;
motor [frontright] = -127;
motor [backright] = -127;
waitlMsec(900);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
waitlMsec(50);
```

Listed on this page is the code for the autonomous program and autonomous period. It can be noted that the functions and commands for each aspect of the robot can be found next to the "//" symbol listed before and above each section of coding. For clarification, the functions are ~~highlifed~~ highlighted to make them more evident.

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## Drive Programming 2/1/18

```
task usercontrol()
{

  while (true)
  {
      //joystick control:
           motor[leftdrive] = vexRT[Ch3];
           motor[frontright] = vexRT[Ch2];
           motor[backright] = vexRT[Ch2];


  //lift control

  if(vexRT[Btn5D]==1){


  motor [drfleft] = 127;
  motor [drfright] = 127;

  }else if (vexRT[Btn5U]==1){
        motor [drfleft] = -127;
        motor [drfright] = -127;

  }else{
        motor[drfleft] = 0;
        motor[drfright] =0;

  }

  //pick up for first 3 cones
  if(vexRT[Btn8U]==1) {
        //claw closes
        motor [claw] = 127;
        wait1Msec(200);

        motor[claw] = 0;
        wait1Msec(50);

        //lift moves up
        motor[drfright] = -127;
        motor[drfleft] = -127;
        wait1Msec(400);

        motor[drfright] = 0;
        motor[drfleft] = 0;
        wait1Msec(50);

        //chain moves over
        motor[chainleft] = 100;
        motor[chainright] =100;
        wait1Msec(700);

  motor[chainleft] = 0;
  motor[chainright] =0;
  wait1Msec(50);

  //lift moves back down
  motor[drfright] = 127;
  motor[drfleft] = 127;
  wait1Msec(200);

  motor[drfright] = 0;
  motor[drfleft] = 0;
  wait1Msec(50);

  //claw opens
  motor[claw] = -127;
  wait1Msec(200);

  motor[claw] = 0;
  wait1Msec(100);

        //lift moves back up


  motor[drfright] = -127;
  motor[drfleft] = -127;
  wait1Msec(400);
```

The lines highlighted in purple indicate that channel 3, the left joystick's vertical axis, will control the left drive of the robot, and channel 2, the right joystick's vertical axis, will control the front and back motors on the right side of the drive.

When button 5D of the controller is pressed, the left and right motors of the DRFB will move at full speed, and the lift will move down. This lines are shown in green.

In orange, the code represents when button 5U is pressed on the controller, the DRFB will move at reverse full speed, and the lift will move up.

The lines highlighted in magenta show that when the buttons on channel 5 are not pressed, the left and right DRFB motors will not move.

The code under the line highlighted in red show that the code is for channel 8, which controls the autostacker. The auto-stacker stacks cones on the mobile goal at the push of a button, using the timer "wait1Msec" function. There are 4 buttons in channel 8: 8U, 8R, 8D, and 8L. Button 8U is used to stack the first 2 cones, 8R stacks the next 2 cones, and so on. Then, the times for moving up the lift are increased with each consecutive button to account for the increased height of the existing stack on the mobile goal.

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Drive Programming (cntd.)

```
motor[chainleft] = 0;
motor[chainright] =0;
wait1Msec(75);

//lift moves down
motor[drfright] = 127;
motor[drfleft] = 127;
wait1Msec(900);

motor[drfright] = 0;
motor[drfleft] = 0;
wait1Msec(50);

}
```

The following code in this column illustrates the continued program for the auto-stacker.

```
//pick up for next 3 cones
if(vexRT[Btn8D]==1) {
    //claw closes
    motor [claw] = 127;
    wait1Msec(200);

    motor[claw] = 0;
    wait1Msec(50);
```

In the lines in green, the left and right motors of the chain bar run at reverse full speed, and the chain bar moves down when 7D is pressed.

```
//lift moves back down
motor[drfright] = 127;
motor[drfleft] = 127;
wait1Msec(150);

motor[drfright] = 0;
motor[drfleft] = 0;
wait1Msec(50);

//claw opens
motor[claw] = -127;
wait1Msec(200);

motor[claw] = 0;
wait1Msec(100);

//lift moves back up
motor[drfright] = -127;
motor[drfleft] = -127;
wait1Msec(400);

motor[drfright] = 0;
motor[drfleft] = 0;
wait1Msec(50);

//chain moves back over
motor[chainleft] = -60;
motor[chainright] = -60;
wait1Msec(500);
```

The gray lines show that 6D makes the claw motor move at full speed, and the claw closes.

The selected lines in yellow show that the speed is reduced to prevent forceful slamming of the chain bar as it moves down. As it travels from a higher distance, it slams down harder, causing the speed to be reduced further.

```
    motor[claw] = 0;
    wait1Msec(100);

}

//chain control
if(vexRT[Btn7U]==1){

motor [chainleft] = 127;
motor [chainright] = 127;

}else if (vexRT[Btn7D]==1){
motor [chainleft] = -127;
motor [chainright] = -127;

}else{
motor [chainleft] = 0;
motor [chainright] = 0;

//claw control

if(vexRT[Btn6D]==1) {
    motor[claw] = 127;

}else if (vexRT[Btn6U] ==1) {
    motor[claw] = -127;

}else{
    motor[claw] = 0;
    }

//mobile goal control
    if(vexRT[Btn7R]==1){
    motor[mogo]=127;

}else if (vexRT[Btn7L]==1){
    motor[mogo] = -127;

}else{
    motor[mogo] = 0;

    }
}
    UserControlCodePlaceholderForTesting();
  }
```

Here lies the end of the auto stacker code.

The lines in dark blue show that when 7U is pressed, the left and right motors of the chain bar ~~mo~~ run at full speed, so the chain bar moves up.

In pink show that when neither 7U or 7D are pressed, the chain bar motors do not run.

The purple lines tell us that the claw motor runs at reverse full speed, and the claw opens with button 6U.

In blue, shows that when buttons on channel 6 are not pressed, the claw motor does not run.

Orange lines show that 7R causes mobile goal motor to move at full speed, and the mobile goal lift moves out.

Red lines show that 7L makes mobile goal motor to run at reverse full speed, and the mobile lift moves in.

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Joystick control 2/2/18

Listed below is our joystick control/user control, showing the function of each button for our robot.


We arranged our wires in an organized manner using spiral cable wraps. In this way, our wires will not get tangled and will enable the controls of the joystick to work.

The controls located on the right side of the surface of the joystick control the auto stacker.

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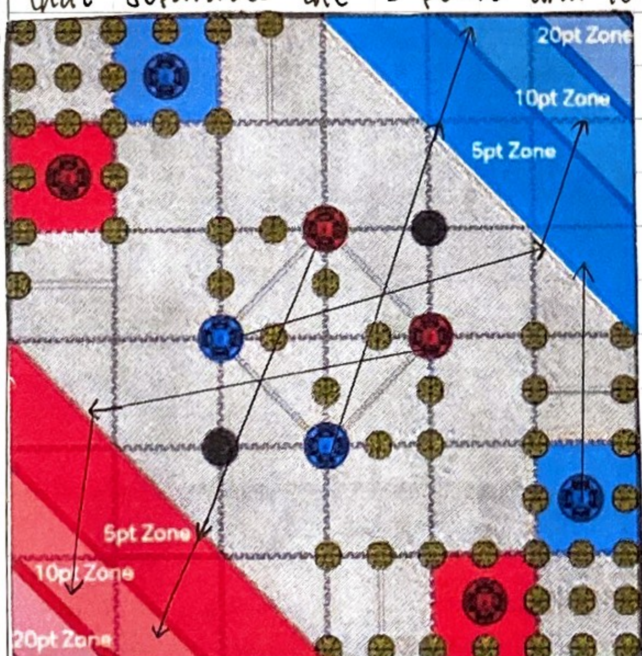
Strategy 2/2/18

In order to practice our driving and auton period, we set up a field with our own materials to make it feel like the real thing, that is, the competitions.

Skills strategy:

For skills, we are going to line our robot up at the middle of the PVC pipe that separates the 5 point and 10 point zone. To begin scoring, we will score the two ~~cones closest~~ mobile goals closest to the middle of the field into the 10 point zone. Then, we will drive to the opposite end of the field where the other zone is located and from there, take the two mobile goals in the middle and score them into the 10 point zone. If time allows, we will take one of the cones at the sides and score one of them into the closest zone.

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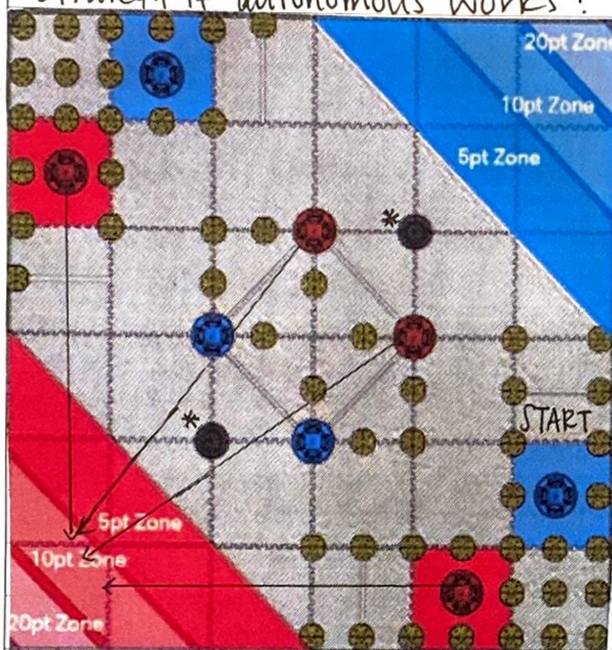
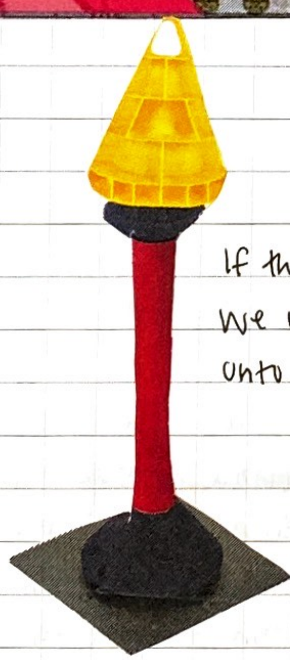
## Strategy (cntd.)

Strategy if autonomous works:

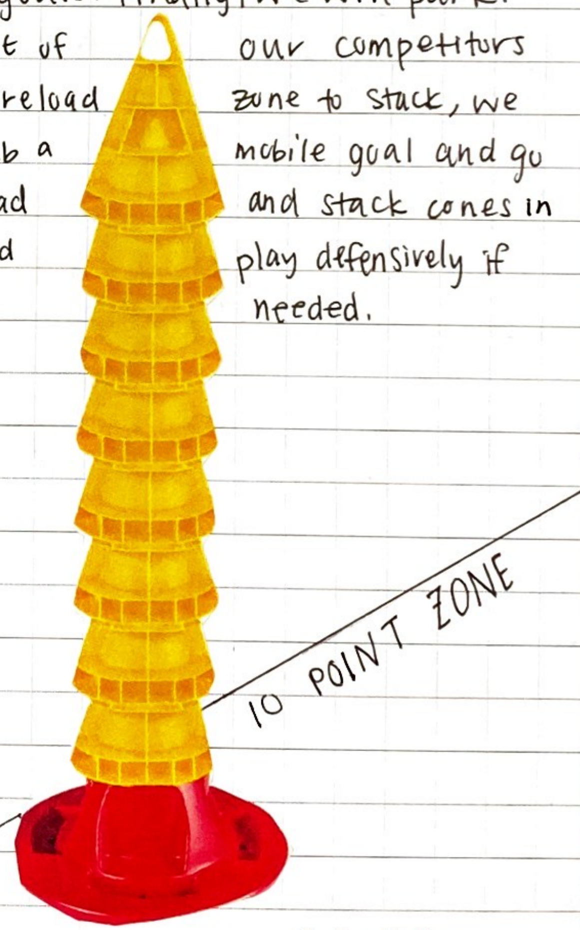



If our autonomous code works, we will ideally have 14 points scored. From there, we will grab the mobile goal on the right side of the middle field (since we start off on the right side) and begin stacking cones and place it into the 10 point zone. Then, if another mobile goal is available, we will bring it to the 10 point zone. If none are available, we will stack onto stationary goals. Finally, we will park.

In the event of our competitors using the preload zone to stack, we will first grab a mobile goal and go to their preload and stack cones in their area, and play defensively if needed.



If there is time remaining, we will aim to stack onto the stationary goals.




Our goal is to stack 8 cones onto a mobile goal into the 10 point zone.

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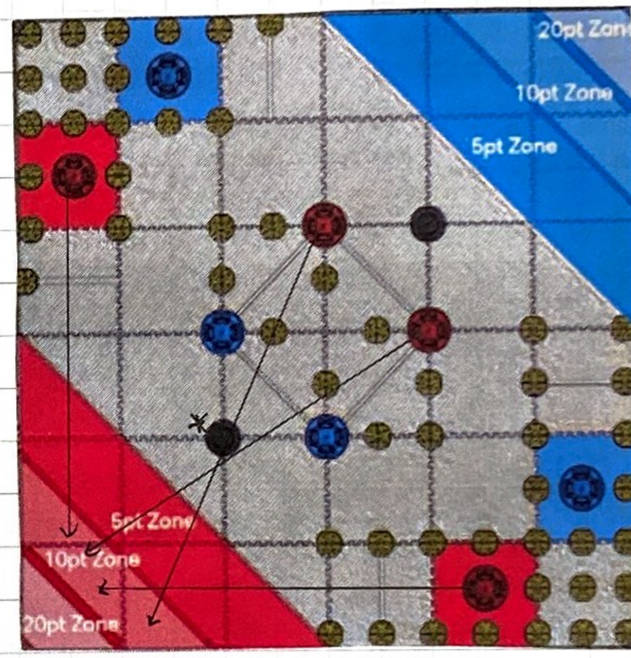
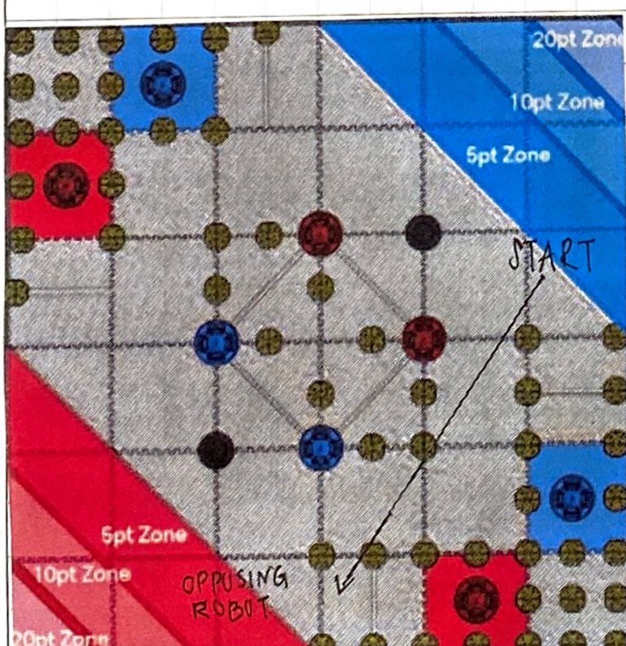
## Strategy (cntd.)

Strategy if autonomous does not work:

If our autonomous does not work, the mobile goal of our corresponding alliance will still remain. If this happens, we will drive to that mobile goal, pick it up, stack cones on top, and place it down in the 10 point zone. If there are other mobile goals available, we will bring them into the 10 point zone. If not, we will stack onto stationary goals. Same defense strategy ~~if au~~ as if autonomous does work.




It can also be noted that if we get the highest stack, we can earn more points. Additionally, if our alliance team wins the autonomous period, we can earn more points.




Strategy for autonomous defense:

In the autonomous round, we could also play defense if something were to occur with our initial autonomous plan and code. That is, we will program the robot to move in a line towards the opposing robot to block their autonomous. In this way, the opposing team would not score as many points.

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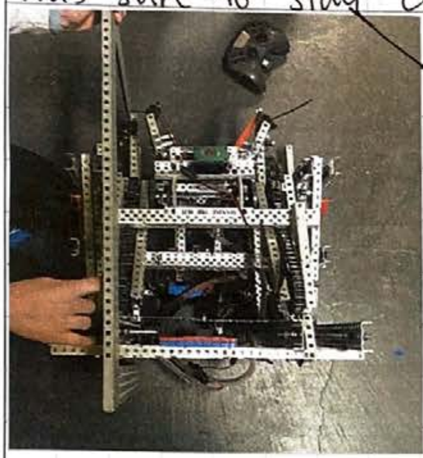
Night Before Competition 2/3/18

As competition day is right around the corner, we practiced our autonomous and driving. We want to be sure that our driver is comfortable with our robot and that she is confident with the control buttons and the overall joystick. Through this last minute practice session, our driver was sure to stay confident despite the apparent pressure from team-mates. We also checked our robot for any loose nuts or screws. Our robot went through a size check, to be sure that it met the size requirements. Lastly, we prepared our bag full of materials and equipment for tomorrow.



← Our robot successfully meets the size requirements!

Competition Checklist 2/3/18

- ☑ 3 batteries with chargers
- ☑ Replacement wires
- ☑ Toolbox
- ☑ Gearbox
- ☑ Glasses
- ☑ Joystick
- ☑ AAA batteries
- ☑ Friction Padding
- ☑ Rubber bands
- ☑ Foam
- ☑ USB (Cortex cable)
- ☑ Computer
- ☑ Robot

Goals for Competition 2/3/18

Our goal for the Millburn competition is to, as always, do our best. We want to stand out from the plethora of robots and teams tomorrow. Although we would like to win at least one award, we know that if we do not, that is acceptable as well. We believe that we put in our full effort and truly want to gain knowledge from the competition to further the efficacy and design of our robot.

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Day of Competition 2/4/18

Today, we all woke up at 5am and departed for Millburn at 6 am. We arrived at the competition at 7:30 am, and immediately went straight to the practice field to test our auton. This is because we are most concerned about our autonomous period. An observation that we immediately noticed was the abundance of teams at the competition! Not going to lie, but we ~~were~~ are pretty motor-vated! We also wanted to test our autonomous on the pit field, but, unfortunately, we were not able to due to the many teams using the field. There is lack of communication regarding how long each team uses the field and taking turns. Consequently, we had to utilize the space at our table to test out our auton.

Problem: After testing our autonomous, we went over the 15 seconds by less than a second.

Solution: We met the 15 second time limit by reducing the number of cones we stack on mobile goal by one. Although this lowers the amount of points we score in the autonomous period, it will be better to score one stacked cone on a mobile goal into the 10 point zone.

When the matches started, we saw many robots that were very advanced in design. Many robots did not have an autonomous, but were able to score in the 20 point zone and stationary goals in driving.

Problem: During the matches, there are times when the yellow cones dropped into our robot's drive. Even though it was not a hindrance most of the time, we still want to avoid it.

Solution: As of now we do not have a solution, but perhaps ~~we can~~ our driver can have better control and familiarity with the robot.

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Reflection of Millburn Competition 2/4/18

After the Millburn competition ended, we saw how the competitiveness increases at each tournament. Most matches end as a very close match, showing how many robots are at our level of competition. We finished the tournament in 18th place with the second most autonomous skills points. We are pretty satisfied with our ranking considering the fact that there were about 60 teams competing. However, we want to improve so much more to be able to compete in the upper tier of robots. To do this, we plan on altering our robot's design to be able to score in the 20 point zone. Also, at this competition, we were not able to stack 8 cones like we previously planned. Instead, we only could stack 2-3 cones due to the time constraint, and our need to score all mobile goals. Additionally, considering how we scored more autonomous points than many other teams, we want to be able to score more points, than we currently can, for future tournaments. Perhaps we can try scoring in the 20 point zone in the autonomous period since we are improving our design to be able to score in the 20 point zone without getting stuck. This was another problem we encountered. We want to ~~be abl~~ go into an in-depth analysis of each part of our robot, noting what works, why it works, and what we can improve upon. We want to do this because we know that we could have done better in this tournament, and wish to do a lot better in the next competition. To include, we will change our code accordingly to make it to the 20 point zone.

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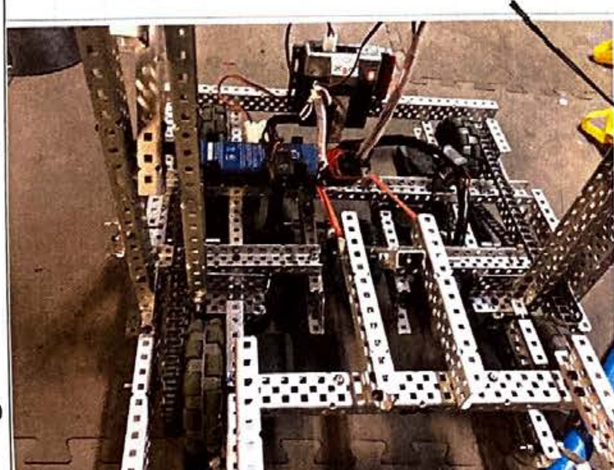
Changes in Design 2/6/18

In order to avoid getting stuck in the zones for 10 points, we took off the c-channels on the bottom of the drive to the top of the drive. In this way, we can reach the 20 point zone with ease. However we ~~ott~~ were initially doubtful regarding whether or not the mobile goal lift would still be stable with the added changes. This is because the 2 c-channels are now on top instead of the bottom, where they functioned as stability measures. Luckily, this served to not be a problem since the c-channels passed both sides of the wheel-wells on both sides. To add further stability, we utilized lock nuts to secure the c-channels.

With these new changes in design, we performed trial runs to see how many more points we can score in the 20-point zone, or 10-point zone. We set up these trials following the competition setup with 1 minute and ~~30 seconds~~ 45 seconds. Actually, we conducted the trials in 1 minute and 30 seconds to account for anything to happen at competition.

| | #Cones | Zone | Total Points |
|---|---|---|---|
| Trial 1 | 5 | 20 | 30 |
| Trial 2 | 4 | 10 | 18 |
| Trial 3 | 4 | 10 | 18 |



← Here, we see that the 2 C-channels are now placed on top.

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The Robot's Center of Gravity 2/8/18

In the game, the robot is required to stack a multitude of yellow cones onto both stationary goals and mobile goals. Since we have a tall lift, maintaining stability is one of our primary concerns. Whenever we stack over 4 cones onto our robot, the robot starts to shake. This is caused by the shift in the center of gravity in the robot. Previously at the Millburn tournament, in one of the qualification rounds, our robot tipped over. So, though, we do not have an anti-tip structure, our mobile goal can, to an extent, help to provide extra stability.

1 Yellow Cone's Effect:

Robot = 16 pounds    1 yellow cone = 0.26 pounds

% of change equation = $\left(\frac{0.26 \text{ lbs}}{16 \text{ lbs}}\right)100$

$= 1.625\%$

The weight of 1 yellow cone has a 1.625% effect of weight to the robot's speed.

Maximum Amount of Yellow Cones (9) Effect:

Robot = 16 lbs    9 cones = (0.26)(9) = 2.34 lbs

% change $= \left(\frac{2.34 \text{ lbs}}{16 \text{ lbs}}\right)100$

$= 14.625\%$

The weight of 9 yellow cones has a 14.625% effect of weight to the robot's speed.

9 Yellow Cones + Mobile Goal Effect:

Robot = 16 lbs    9 cones + mobile goal = 2.34 lbs + 4 lbs = 6.34 lbs

% change $= \left(\frac{6.34 \text{ lbs}}{16 \text{ lbs}}\right)100$

$= 39.625\%$

The weight of 9 yellow cones and mobile goal has a 39.625% effect of weight to the robot's speed.

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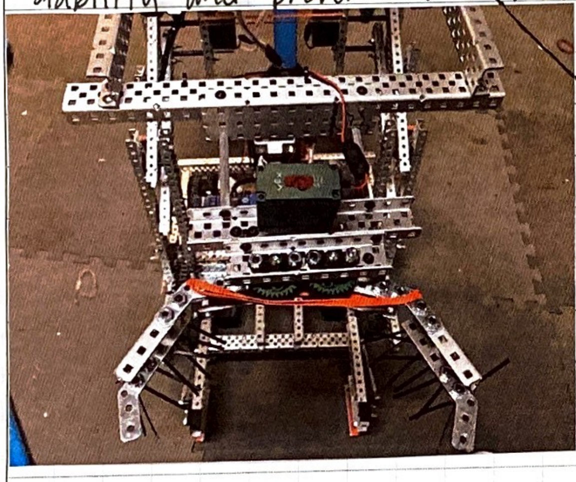
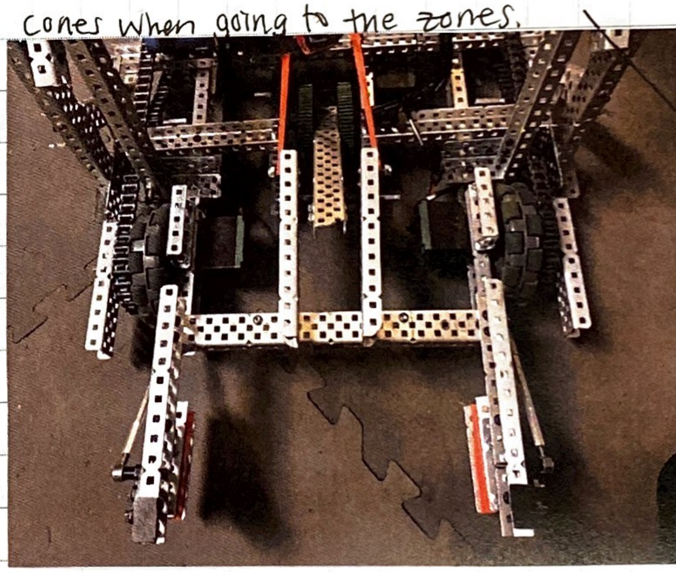
## The robot's center of Gravity (cntd.) 2/8/18

Since our ultimate goal in each tournament is ~~to~~ stack 9 yellow cones onto the mobile goal and to then place the entire system into the 10 point zones, a percent change of 39.625% is incredibly high. Our robot will experience both a reduction in speed as well as significant instability. The mobile goal lift can partially step in as an anti-tip structure. Also, by closing the claw on the topmost cone on the stack, we can ensure further stability and prevent the robot from tipping over.



Here, is our claw. With its structure comprised of ziptides and a claw shape, the robot can be less likely to tip since it can grasp onto the stacked cones when going to the zones.



Here, is our mobile goal lift. By grabbing and moving the mobile goal and stacked cones into the center of our robot, we can hope that our robot is less likely to tip over.

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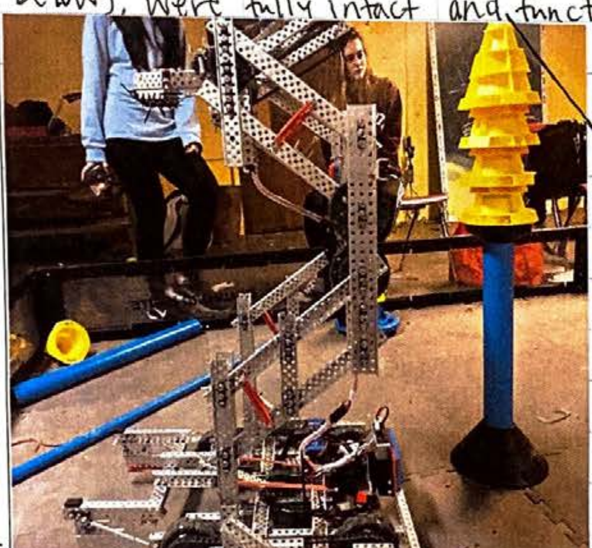
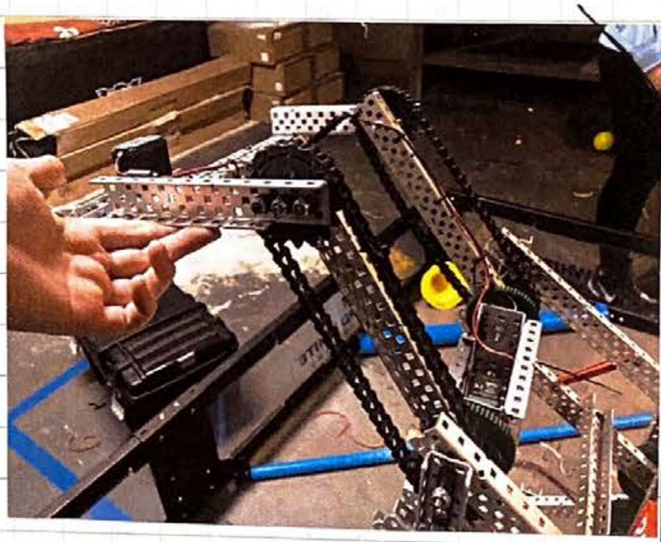
## Night Before Competition 2/9/18

Today, we practiced our driving of the robot at our school's field rather than our homemade field setup. By doing so, we got a better and more realistic feel for tomorrow's competition. We saw that our driver was much more apt and fluid with her handling of the joystick control. As a result, our robot was better at picking up cones and stacking them. We also practiced going into the 20 point zone, as it is new to our robot's list of abilities. We established that our robot would aim for the yellow cones that are in view/sight, rather than attempting to pick up cones that were in front of the robot, blocking our driver's ability to see them to ensure a secure grasp on the yellow cone. Lastly, we were sure to check our robot, like the lift and chain bar lift (as seen below), were fully intact and functionable.





## Competition Checklist 2/9/18

| | | |
|---|---|---|
| ✓ 3 batteries with chargers | ✓ Joystick | ✓ USB (Cortex Cable) |
| ✓ Replacement wires | ✓ AAA batteries | ✓ Computer |
| ✓ Tool box | ✓ Friction padding | ✓ Robot |
| ✓ Gear box | ✓ Rubber bands | |
| ✓ Glasses | ✓ Foam | |

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Day of Competition 2/10/18

Today, we arrived at Millville High School at 7 am and immediately got to work on our auton. Our auton has been experienced problems with picking up the mobile goal, and rotating the right amount to be in front of the zones.

Problem: While working on our program, our robot was not functionning once auton was over. When we tried to drive the robot, the user control joystick did not move the parts of our robot.

Solution: We realized the auton was in a while loop, so once we turned the loop off, our robot was able to work again.

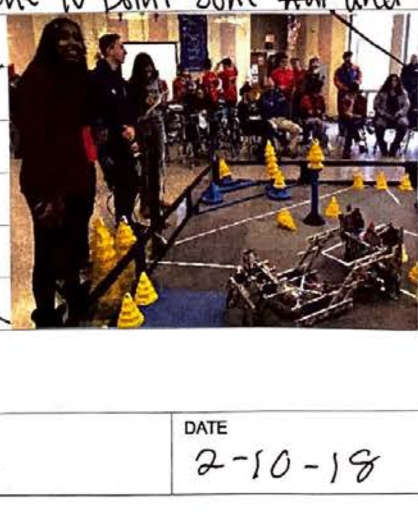
Problem: The mobile goal lift is not picking up the mobile goal, even though the mobile goal is fully in the mobile goal lift.

Solution: We discovered that the mobile goal lift was stalling. Our only solution at this point (since matches start very soon), is to wait until the lift stops stalling.

Problem: Many of our rubber bands ~~spa~~ snapped off our double reverse four bar lift and mobile goal lift.

Solution: Because one rubber band snapped off, we had to change all 3 of our rubber bands. We also put new rubber bands on the mobile goal lift.

During programming skills, we scored 24 points rather than 14 points. The robot somehow surpassed the 10 point zone ~~that~~ and dropped the mobile goal with 2 cones onto the 20 point!



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Reflection of Millville Competition 2/10/18

At the end of the tournament, we ended with 24 points in programming skills and 44 points in driver skills, making us 7th place in skills. We concluded qualification rounds 4-1 and ended in 7th place overall as well. Also, before each match, we met with our alliance team and discussed a thorough strategy plan, after we DQed in our first match. We think that this greatly helped us win the next 4 rounds. In Semifinals, we got picked in alliance #4, however, lost to alliance #1. We still believe that we did exceptionally well, possibly our most successful tournament. We were aiming for the Design Award, yet was not awarded any awards. Since the next competition is state level, we want to focus not only on speed and efficiency in driving, but also on our notebook. We hypothesize that we need to add more details and content about the build of our robot. So, we will begin to revisit past topics and talk about our journey with more details and information. We hope that with these new future additions, we will be able to get recognized for our notebook and the process of how we ended up with our current robot. These next pages will be part of our reflection on the robot as a whole and how we think we will prepare for the State-Level competition in approximately a week.

Looking back, we realize that during our first match, we could have prevented getting disqualified from that match. That is, the opposing robot was lingering at our 5 point zone, blocking our pathway to the 10 point zone. Instead of going around the robot, we pushed through and accidentally pushed the opposing robot into our zone, causing us to become DQed. We realize now that we could have alerted our driver and gone around our opponent. We also realize that during semifinals, we could have gave our driver clearer instructions as to which yellow cones to go for and what to score after the other.

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We wish to conduct an in-depth analysis and reflection of our robot. We want to focus on each aspect of the robot, highlighting what functions well and what requires improvement. Thus, we will be fully familiar and knowledgeable on our robot and its design, allowing us to completely understand and operate our robot skillfully for competitions.

Part 1: Old Robot to New Robot Transformation 2/10/18

Looking back at our first robot, we have successfully transformed the small chain bar into a competitive double reverse four bar lift with a chain bar lift. Our first robot could only stack a total of 3 cones, and it was not a reliable robot when stacking cones. The new robot is able to stack a total of 8 cones and is much more reliable when stacking. The mobile goal lift is able to carry a greater amount of weight and now successfully places the mobile goal with 2 cones on it into the 20 point zone. Understanding the strategies for the competitions helped us to also improve the amount of points that we could earn during a match. For example, before the match started, we would look at our opponents' robots as well as their performances to understand what we are competing against. Then, we meet up with our alliance and ask and discuss what their robot is capable of doing during the autonomous period and drive period. After telling our alliance what our robot can do in terms of scoring, we strategize a plan with our alliance, covering which mobile goals to aim for as well as when to stack on stationary goals, and defense skills.

After 4 competitions we have improved in the skills competition, our autonomous period, and our driving. As a team, we have spent weekdays and weekends staying up late to make sure that our robot could be the best it could possibly be. There has been many problems, and most likely more future problems with our robot, but there has not been a problem that we were not willing to try and fix.

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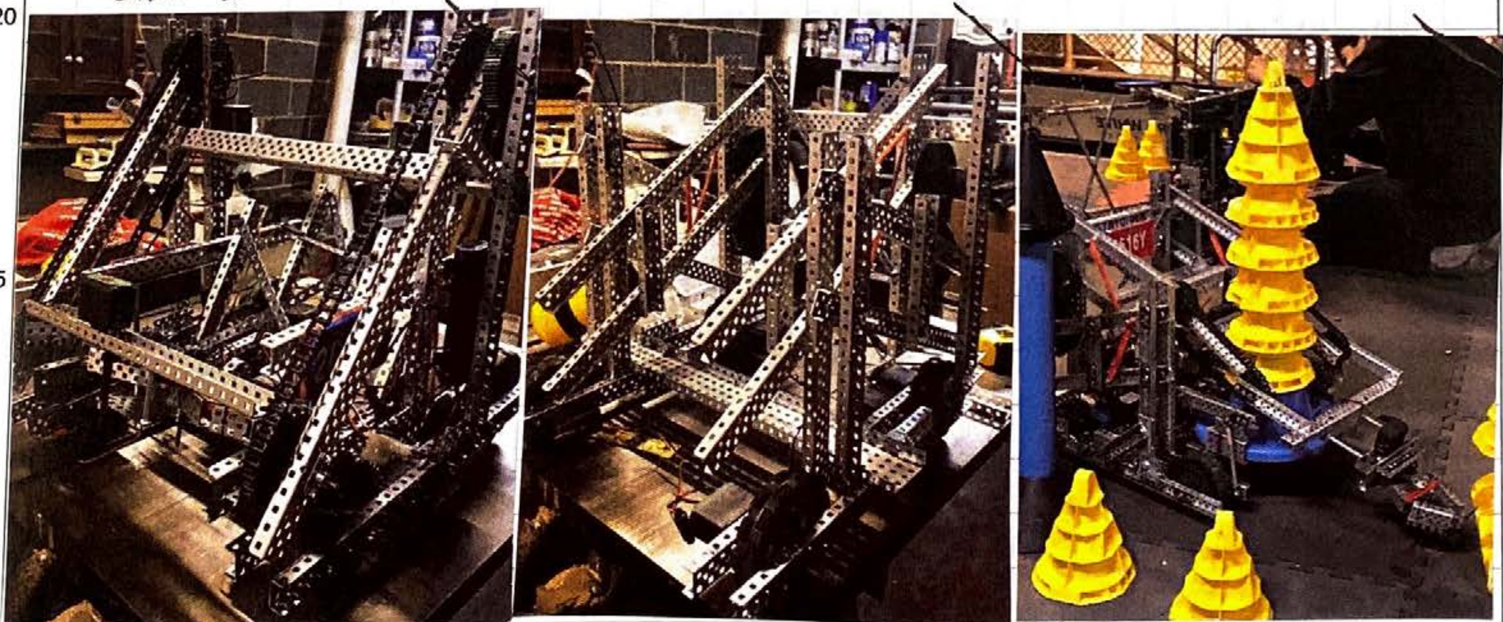
Overall, we have all improved in our team roles, and we are hoping that we can show how far we have come during the states competition on February 24th. For instance, during the judges' interview at our most recent tournament, we were able to impress the judges with our robot's design, specifically the ziptides on the claw acting as teeth fr the robot, and our programming, specifically our autonomous period as we were able to program the robot to pick up the mobile goal with 2 cones stacked, all into the 10 point zone. From our first competition at Camden County Technical School to our latest competition at Millville HS, we have improved in our total scores: our offensive power ranking (OPR) increased from 17.4 to 26.4, showing that we have become a stronger team, our Defensive Power Ranking (DPR) went from 16.0 to 9.9, showing that we have become a stronger team with a lower value, our Calculated Contribution to Winning Margin (CCWM) went from 1.5 to 16.4, a significant improvement, while the number of bonus Autonomous Points (AP) went from 20 to 10, showing that we should improve our auton since it is evident that more teams are gradually having advanced autons.

Chain Bar → Making the DRFB → DRFB + Chain bar



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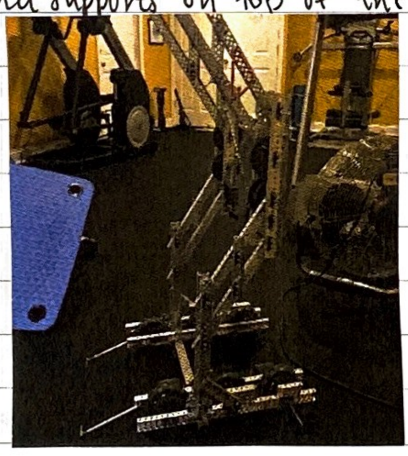
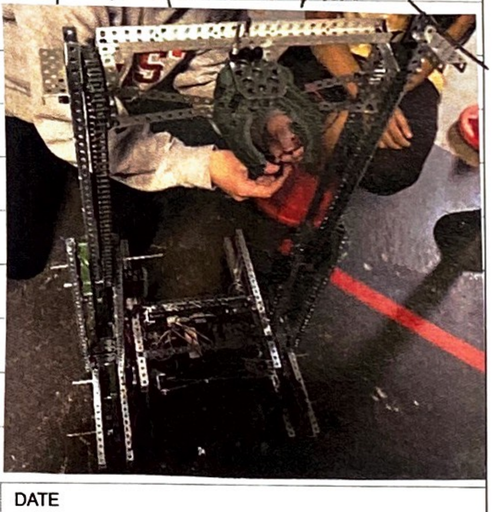
Part 2: Design Finalizations and Descriptions 2/11/18

Drive -

The drive is the most important part of any robot, as it is what connects the robot to the ground, allowing it to move. Initially, we designed the drive with 4 omni-wheels (directional) and 2 friction wheels in between on each side of the drive, while having a chain run across 2 sprockets next to the wheels. After testing, we realized that the friction wheels made it harder to get over the 10 point bar, so we ended up removing them. The other problem with getting over the 10 point bar was because we had 2 c-channels underneath the drive running from one side of the drive to the other for stabilizations and strength. To fix this, we ended up moving the c-channels to the top, which also connected to the mobile goal lift. Now, the drive can successfully pass over the 10 point pipe with ease. Additionally, the advisor of the robotics club questioned why our robot was so fast. We changed out the regular motors for speed gears for for all 4 motors on the drive. Many other robots on our club use speed motors for the drive, so we ended up racing 2616J team and discovered that even though we had a similar amount of metal, our robot is much lighter, making it faster. Also, since our robot is lighter, it requires less torque to move around. To summarize the final design, we ended up with 4 speed motors, 4 omni-wheels with sprockets, chain connecting the sprockets, and structure and supports on top of the drive.





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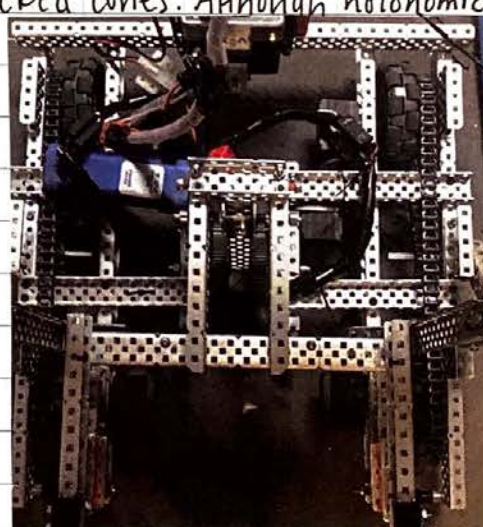
Drive (cntd.) —

Wheel selection:

For wheels, we settled on four, 4 inch diameter omni-directional wheels. Our options were the omni-directional wheels, high traction wheels, and mecanum wheels. Mecanum wheels were quickly ruled out since their main advantage is to strafe, which is not necessarily beneficial to this competition. High wheel traction wheels are not ideal either because the turning scrub is too narrow, especially for a robot as heavy as ours (at 16 pounds). Furthermore, the 4 inch wheel was best suited for this match as opposed to the 3.25" and 2.75" wheels as it provided the greatest speed of approximately 3016. This was calculated by multiplying the circumference by the revolutions per minute.

Drive Type:

Ultimately, we settled on a tank drive for its versatile structure and the wide range of motion it provides. Another factor that we took into account is how how constructing a tank drive is relatively easy, especially beginners. The biggest issues with holonomic and mecanum drives is that it may be difficult to get the robot over the 10 point and 20 point bars. With holonomic drives, there is the risk of the robot potentially stalling due to the large amount of weight placed onto the drive with the mobile goals and stacked cones. Although holonomic drives allow the benefit of moving sideways without turning, they can be slower. Since our main concern in the competition is speed, tank drives seem to be the best option. With the mecanum drives, the 4 inch omni-wheels are slightly larger than the mecanum wheels, meaning that one of the sides will consistently have less traction, making mecanum drives less than ideal.



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Part 2: Design Finalizations and descriptions (cntd.) 2/11/18

Mobile Goal Lift –

The mobile goal lift on our updated robot is much simpler, yet more effective than that of our initial robot. Our current lift only requires one motor, which allows for the use of motors in other necessary locations. The mobile goal lift includes one bar that has two gears attached to it that are driven by two 12 tooth gears. Then, the metal piece connects to the structure that picks up the mobile goal with an axle running through it. The structure is connected to standoffs, which run from the drive to the top of the mobile goal lift. This allows for a straight pathway to the ground without allowing space to move around. Therefore, the lift is very stable and can carry up to 8 cones at a time. The height of the lift also allows for an easy drop into the 20 point zone, which helps us to score a greater amount of points. The two c-channels that pick up the mobile goal have rubber bands around them to secure the lift once it is in the lift. In the past, we had tried using friction padding; however, the rubber bands have been more reliable as far as picking up and securing the mobile goal in the robot.

Problem: Mobile goal lift was not centered, and chain bar kept hitting multiple cones when stacking.

Solution: There was an uneven amount of spacers where the back gears are, so fixing it centered the ~~chain~~ mobile goal lift while the chain bar no longer hit the cones. Also, the axle became more flexible since it had more space to bend. Thus, we added another support in the middle to send the axle through with a bearing to make the axle less flexible because it was skipping gears and not allowing the lift to pick up the mobile goal.

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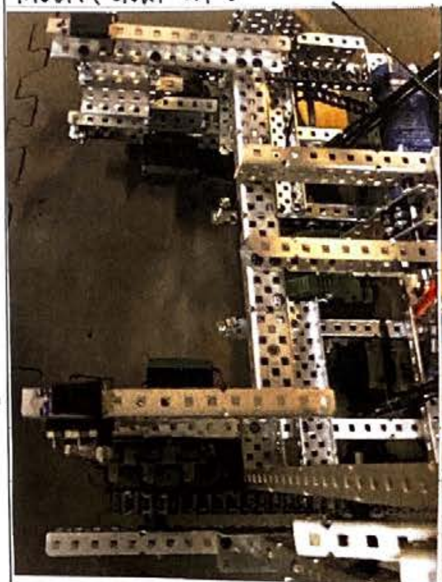
Mobile Goal Lift



Double Reverse Four Bar

Double Reverse Four Bar - 2/11/18

Compared to our original chain bar lift, the double reverse four bar is able to reach much higher. In the beginning, we were unable to stack on stationary. Now, we are able to stack up to 3-4 cones on stationary with ease. The DR4B only uses 2 motors thanks to the plethora of rubber banding that we used on the sides of the lift. That is, the rubber bands help bring the lift up since the lift is so heavy. This lift is the perfect design for the competition because it is able to stack quickly and reach high enough to be able to get the highest stack points. The X bracings on the back of the robot helps with stabilization along with the triangles placed at the base of the lift. The lift has a driving gear which is an 84 tooth. Therefore, this ratio of 1:7, helps the heavy lift to raise without problems. The lift is easy to control and has proven multiple times throughout competition to be extremely reliable because it does not knock off any of the cones that are stacked on the mobile goal lift.

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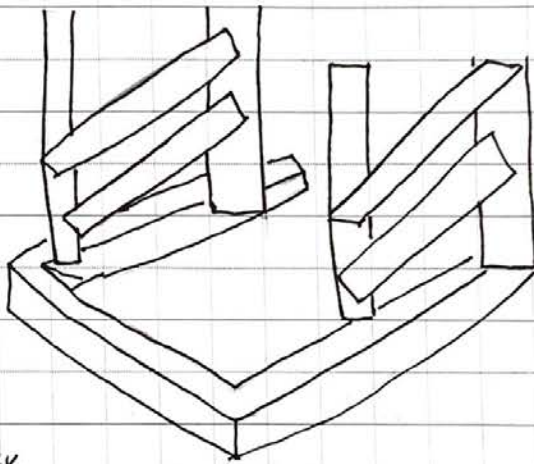
Part 2: Design Finalizations and Descriptions (cntd.) 2/12/18

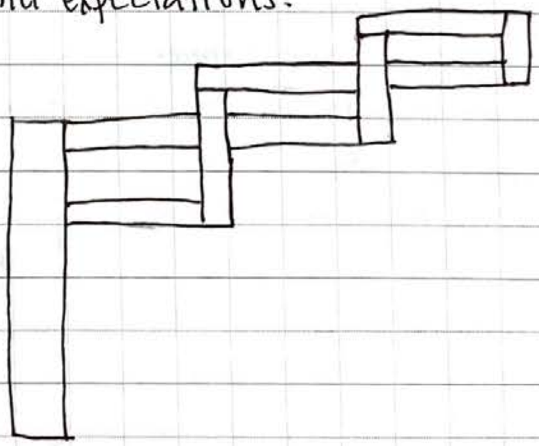
DR4B vs. Other Types of Lifts

- 1 Bar Lift: A one bar lift offers great simplicity, little weight, but little to no control of the cones, leading us to rule it out as an option.

- 4 Bar Lift: Like a one bar lift, a four bar lift is easy to construct, and gives the claw/intake a simple way to always remain vertical. However, this design is not very competitive, not as tall, and thus limited to our needs and expectations.



- 6 Bar Lift: Essentially, a 6 bar lift is a taller version of a 4 bar lift. It was easy to build, and for this reason, it was one of our primary ideas when building our robot. That said, the design is not very competitive or tall compared to other designs.



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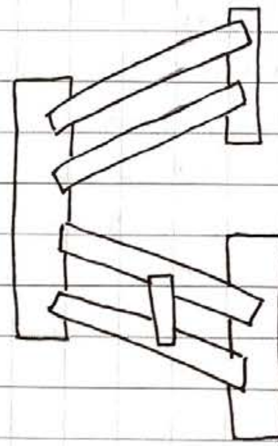
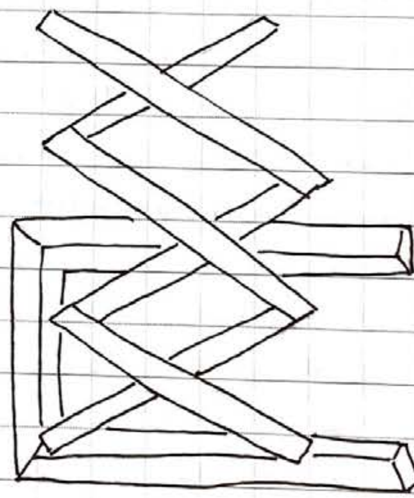
- Double Reverse 4 Bar (DR4B): This lift offers nearly double the height of a simple 4 bar lift. The lift is stable and overall reliable.



It offers a linear path of motion, quick in speed, and slightly easier to drive.

- Scissor Lift: The scissor lift allows for a wide platform to attach mechanisms to, has low friction, less jamming, is easier to power with elastics, but it is harder to maintain and can be slower or less efficient. It has horizontal instability,



has difficulty balancing higher speeds, can tip over, and the lift is heavier than a DR4B that can reach the same heights. Also, the scissor lift uses more metal. It is for these listed reasons that we chose against a scissor lift.

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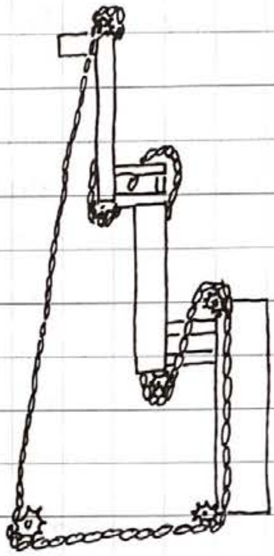
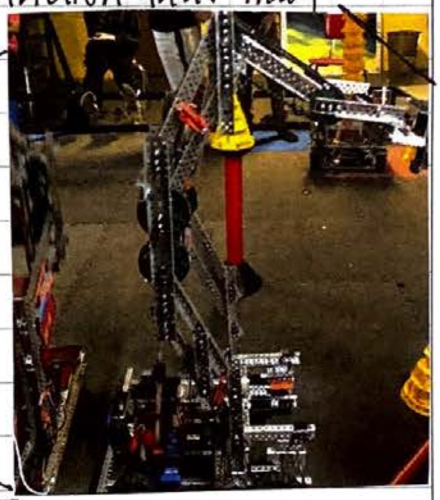
DR4B vs Other Lifts (cntd.) 2/12/18



- Elevator Lift: Generally, this lift is more compact than scissor lifts and the double reverse four bar, but the elevator lift offers more height. However, the lift is very heavy in weight.

- Cascade Lift: Though ideally, cascade lifts can be faster, they also greatly increase the risk of breaking the chain if the lift is too heavy. Thus, the lift requires more motors, it is slightly less stable (especially when working with higher stacks on mobile goals), requires lots of linear slides, as well as the addition of a lubricant, so as to counteract the friction that will slow down the lift.

- Continuous Lift: This lift is more reliable than cascade lifts. It requires fewer motors, as low as 2 motors, requires a lot of linear slides and a lubricant to counteract the friction that may slow down the lift.



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DR4B vs. Other Lifts (cntd.) 2/12/18

Analysis of Lift:

Though each lift design offers a unique variety of benefits and drawbacks, we ultimately selected a double reverse four bar. After hours of research, we realized that the DR4B is very stable and offers an ideal level of height for this year's In The Zone competition. However, we know our driving skills are not yet up to par. For this reason, there is no use in building an overwhelmingly large robot that is difficult to manage, such as a Double Reverse 6 Bar or Scissor Lift. In fact, scissor lifts are notoriously known for their instability at higher altitudes, so in an effort to avoid tippage and a lack of control, we ruled out scissor lifts. Additionally, we ruled out the prospect of doing an n-bar lift simply because we felt that although beginners, we as a team have progressed far enough so as to be able to experiment with more complex designs. A bar design would not be competitive at the world's level, which is where we strive to compete at. Furthermore, we eliminated elevator lifts because although they are more compact, they create the risk of breaking the chain if the lift is too heavy. They can also be slowed down by the high amounts of friction created between the linear slides. Since this is our first season, we wanted to play it safe, hence the DR4B, which appeared to be our best option. Besides, after attending various competitions, analyzing the VEX Forums, and watching videos of matches on YouTube of some of the best teams, we gathered that the DR4B is currently the most popular option for lift.

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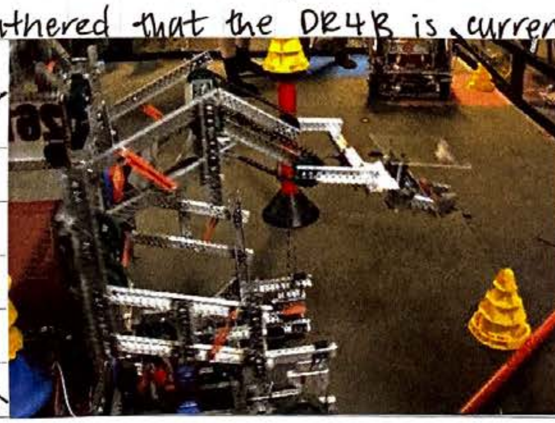

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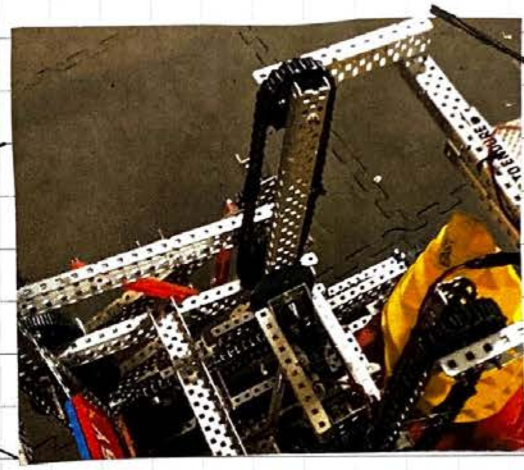
Part 2: Design Finalizations and Descriptions (cntd.) 2/12/18

Chain Bar:

On top of the DR4B, we ended up using the chain bar lift to add extra height. We wanted more height so that we can stack more onto the mobile goal. Before building it, we also considered doing a 4 bar on top; however, since we had experience making the chain bar, we stuck with that design, especially since it is very fast and can accomplish the same tasks as the 4 bar. The chain bar can also easily keep the lift parallel, avoiding lopsidedness.



Types of Intakes - 2/12/18

Since we are only allowed to carry one cone at a time, and since the claw has a rather odd shape to it, we knew from the very beginning of the season that a claw would be the most plausible method of intake. Had carrying multiple cones been an option, side rollers or a bigger claw would have been amazing as they are both fast and efficient, however, this was not the case. Initially, we had the same claw found on a clawbot, but after our first competition, we quickly realized that this mode of intake could only expand so far. As a result, our driver had to be very precise when collecting cones. Since driving is one of our weaker points, we realized a larger claw that opens wider would be more effective in making sure we had cones inside the claw's grasp before closing it. Our claw can also pick up cones that have fallen over by simply attaching the claw to the many ridges on the cone and

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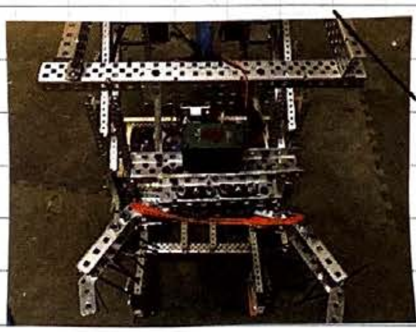
Types of Intakes (cntd.) 2/12/18

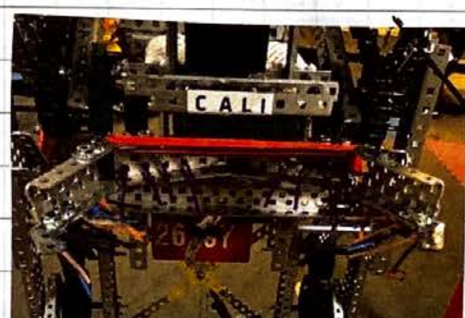
flipping it over. Inside the wider claw, we added zip-ties. Before, we had standoffs in their place, but we quickly realized that the space between the standoffs and cone was not small enough to secure the cone in the claw's grasp.

Passive vs. Active:

We opted for an active intake over a passive intake. Even though passive intakes generally offer more design creativity, they tend to be less effective depending on the driver's skill level. For instance, if a passive intake picks up a cone at a weird angle, it would be more difficult to let go to pick it up again correctly, whereas an active claw offers a lot more flexibility.

Another popular intake design for this year's competition is the rolling intake secured by rubber bands (see page 38). Though we certainly considered this design prior to building our updated robot, we ultimately came to the conclusion that our robot could not offer enough battery power to power the continuous motion of the rolling intake. This is because we have a timed autonomous program, which are known to use a great deal of battery power. We figured the rolling intake was not worth the risk of losing battery during a match. Another thought was a passive intake using a standoff to hook onto a cone. But, we ruled this out since it is not reliable enough.





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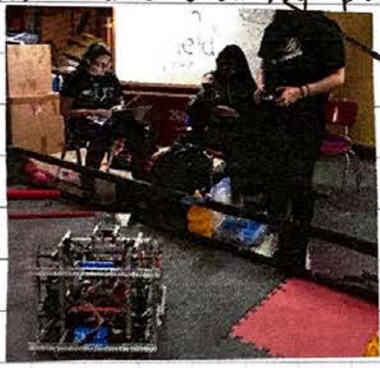
Why Are Driving Skills More Important Than Re-Building At THIS Point? 2/13/18

At this point in the competition, our robot as it is very stable. Of course, if there is a blatant issue, we will make the proper modifications, but there is no use in making changes to the general framework of the robot. Overall, driving skills are far more important because it will maximize the scoring potential.



Issues with Driving 2/13/18

One issue we have been experiencing is that on occasion, it will be difficult for our robot to go into the 20 point zone with ease. After practicing, we realized one way to fix this is by driving over the 10 point bar with high speed and force. Only then will the possibility to getting stuck be minimized. Also, when picking up mobile goals, we must make sure to drop the mobile goal lift completely so as to make sure the mobile goal is completely in the grasp of the lift. Generally, the drive team must improve communication with our driver, Caroline, in keeping her calm throughout the matches, tracking time, and telling her whether to close/open the claw or not, depending on if the cone is at a proper angle for dropping/picking up the cone. This is essential because when the robot is across the field, it will be difficult for our driver to see the entirety of the claw. Also, if the cone drops onto the mobile goal at the wrong angle, this will cause it to get stuck in the drive. Since we will be unable to remove the cone from the drive on our own, the match will essentially go to waste. In other words, the rules of

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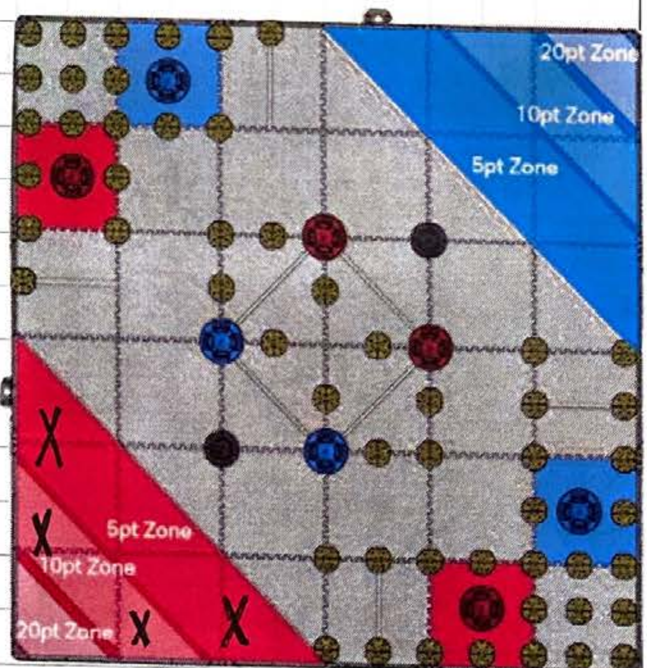
Issues With Driving (contd.) 2/13/18

the competition dictate that a robot may not be in contact with more than one cone, so if a cone were to get stuck, we would be unable to do anything for the remainder of the match. We also need to remember that if we are planning on placing a mobile goal into the 10-point zone, and later putting a mobile goal into the 20-point zone, we must put the mobile goal in the 10-point zone to the sides of the zones. This will allow more space and flexibility when trying to place the mobile goal into the 20-point zone later. Another factor we must take into account is if the robot is moving too fast (or roughly), there is a slight possibility of the mobile goal altering positions, or even slipping out. The one benefit we have with regards to driving is auto-stacking functionality. This makes the actual movement of picking up and dropping (at the right height) a lot more smooth and precise. Regardless, prior to the states competition, we must work on all these different issues so as to ensure that they do not arise during our future matches.

If we were on red alliance, our team and alliance team would have to place the mobile goals so as to not block the pathway to the 20 point zone. Specifically, we would have to place the mobile goal on the ends of the 10 point zone (or 5 point zone) (as seen to the right) to ensure a clear pathway to the 20 point zone.




* The "X" represent areas where it is safe/optimal to place mobile goals *

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Scouting / Alliance Formation 2/13/18

Towards the beginning of the season, our team did not exactly have a strategy for scouting and alliance formation. We more or less were only concerned with our own rankings. However, we quickly realized the errors of our ways after multiple teams started coming up to us and asking us about the specs of our robot. Even if it seems like our team is not likely to make it to alliance captains, it is essential to keep track of the different teams around us, because we will never know what will happen. For example, at our last competition, we were ranked 7th overall. Though this did not warrant us alliance captains, we still had to take into account the other teams because in the case that the top two teams choose to merge, we may be put in the position of having to select teams to be on our alliance. For states, we plan on having a team member go around and ask different teams about what their robot can perform.

Robot Malfunction 2/13/18

During a practice at school, someone was fooling around and stuck a piece of metal into our chain in our chain bar while we were not looking. Then, we went to drive the robot when all of a sudden, our chain in the chain bar lift snapped. We thought that by putting the chain back together, our robot would function normally again. However, this was not the case as our robot would refuse to work.

Problem: The tensions on both sides of the chain bar were different, causing the lift to be tilted, as well as the mobile goal to be not centered.

Solution: We evened out the number of spacers along the mobile goal lift and added support in the middle to avoid skipping gears.

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Friction Padding 2/16/18

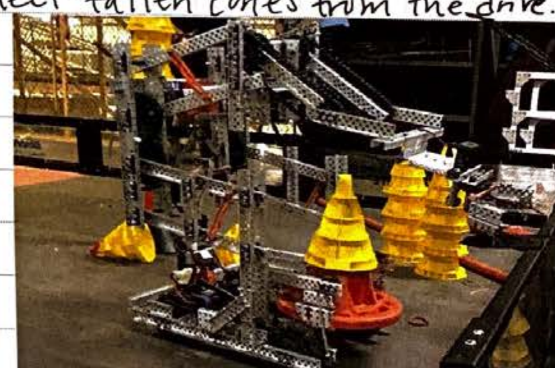
Friction padding can serve our team many purpuses. That is, friction padding can serve as a means of blocking cones, instead of just offering friction. The versatility of friction padding is demonstrated in the following solutions:

Problem: The yellow cones kept getting stuck at the juncture between the chain and claw when we drive and put the lift down to pick up cones.

Solution: We added friction padding at the junction between the claw and chain lift to prevent cones getting stuck there.

Problem: When stacking cones into the mobile goal, there are times when the cone falls from the claw and into our drive.

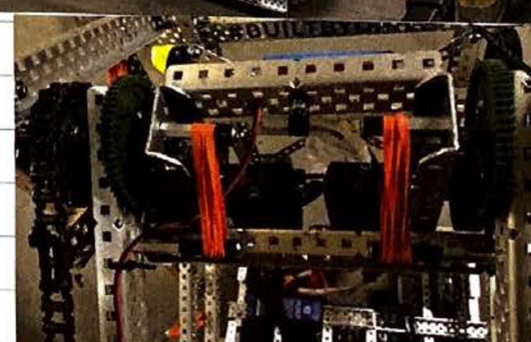
Solution: Although it is not official yet, we are considering adding friction padding hanging from the lift to deflect fallen cones from the drive.



Rubber Bands 2/19/18

Not only do rubber bands provide our mobile goal lift friction, but it helps our lifts to stop slamming down.

Problem: our chain bar lift slams down too forcefully and without smoothness.



Solution: We added rubber bands to the chain bar lift to slow it down when it comes down to lessen the force it exerts when coming down.

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Rubber Bands: The Perfect Amount 2/19/18

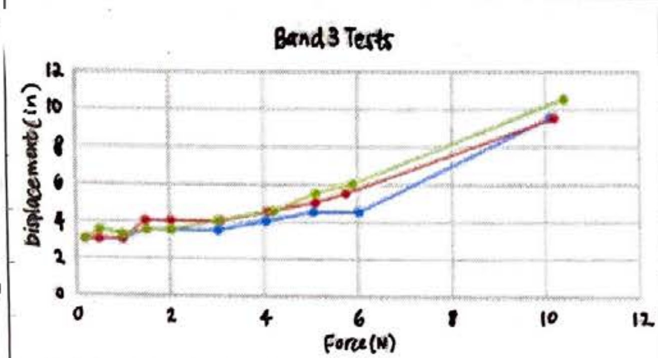
Not only do the rubber bands help the robot's lift to hold its position at any height, but they take the strain of the motors used to power the lift. Using too many rubber bands may result in the lift refusing to go down, thus not fitting into the 18"x18" required starting position. So, it is essential to determine the correct number of rubber bands for the lift. Rubber bands also need to be placed to connect 2 points that get closer together as the lift goes up, otherwise they will resist the motors and cause problems.

We decided to set up a lab to determine the ideal amount of rubber bands to use. To do this, we gathered a variety of weights from the physics classroom and measured the deflection of the weights to find the pull back force. Deflection is the change in an object's velocity as a result of contact/collision, with an influence of a field. The purpose of banding in a triangular shape is to have more uniform tension. Rubber bands are cheap enough that maximizing tension gained from each is not necessary, but having uniform tension at all lift heights is useful.

Figure 1:

| Test | Stretch 1 | Stretch 2 | Stretch 3 | Stretch 4 | Stretch 5 | Stretch 6 | Stretch 7 | Stretch 8 | Stretch 9 | Stretch 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1(in N) | 0.2 | 0.51 | 1 | 1.51 | 2.02 | 3.03 | 4.05 | 5.06 | 6.03 | 10.1 |
| in | 3 | 3 | 3 | 3.5 | 3.5 | 3.5 | 4 | 4.5 | 4.5 | 9.5 |
| 2 (in N) | 0.2 | 0.5 | 1.01 | 1.49 | 2.03 | 3.09 | 4.1 | 5.11 | 5.76 | 10.2 |
| in | 3 | 3 | 3 | 4 | 4 | 4 | 4.5 | 5 | 5.5 | 9.5 |
| 3 (in N) | 0.19 | 0.51 | 1 | 1.52 | 2.04 | 3.03 | 4.22 | 5.12 | 5.9 | 10.4 |
| in | 3 | 3.5 | 3.25 | 3.5 | 3.5 | 4 | 4.5 | 5.5 | 6 | 10.5 |
| Avg Force | 0.1966667 | 0.50666667 | 1.00333333 | 1.50666667 | 2.03 | 3.05 | 4.1233333 | 5.0966667 | 5.8966667 | 10.23333 |
| Avg distance | 3 | 3.166667 | 3.0833333 | 3.6666667 | 3.666667 | 3.83333333 | 4.3333333 | 5 | 5.3333333 | 9.8333333 |

Figure 2:




The blue line represents 3 rubber bands, showing how 3 number of bands is most optimal for our robot. The line~~s~~ have the least displacement, so it is the most ideal amount to use for our lift.

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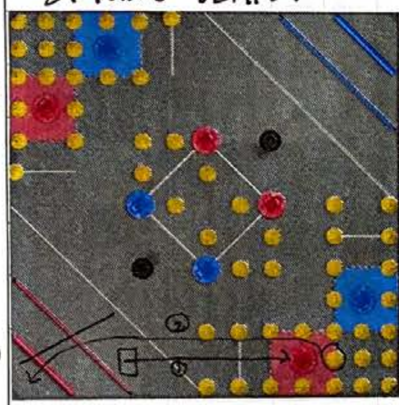
Skills Auton 2/20/18

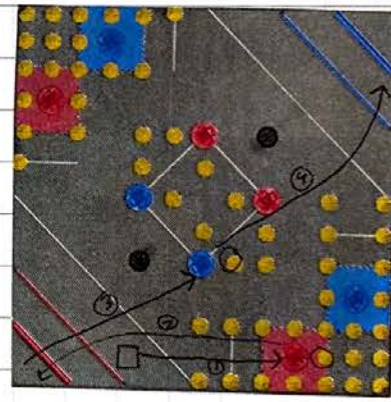
Due to the fact that the skills autonomous period is 60 seconds long but the competition autonomous period is 15 seconds long, we believe we can program our robot to score more points during the skills autonomous period. With extra time, we will be able to stack an additional cone onto the mobile goal and move into the 20 point zone with a total of 24 points, scoring 2 to 12 more points than our competition autonomous period. We are working on autonomous code to score 36 points by turning around, stacking one cone onto a mobile goal, and moving it into the 10 point zone. Below are field diagrams showing the two possible scoring strategies for the skills auton:

24 point skills:



Robot moves forward and drops a cone onto the mobile goal, adds another cone, goes into 20pt zone

36 point skills:



Follows 24 point strategy, but turns after, grabs a mogo, adds a cone, goes into 10 pt zone

Since our competition auton scores 22 points (see page 84), the code for the 24 point skills auton simply adds that the lift and chain move over and the claw opens to pick up the next cone and drop it onto the mogo. The 36 point skills auton uses this code but adds the commands to turn and move the mobile goal in the 10 point zone. Both skills autons will be tested on competition day to determine their success rate. Ideally the 36 point will be used, but if the success rate is less than 85%, the 24 point auton will be used.

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Final Auton Code 2/20/18

```
//bring mogo back in
motor [mogo] = -127;
wait1Msec(1000);

motor [mogo] = 0;
wait1Msec(100);

//move lift back down
motor [drfleft] = 127;
motor [drfright] = 127;
wait1Msec(950);

motor [drfleft] = 0;
motor [drfright] = 0;
wait1Msec(100);

//move back
motor [leftdrive] = -127;
motor [frontright] = -127;
motor [backright] = -127;
wait1Msec(1590);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
wait1Msec(100);
```

```
//move forward
motor [leftdrive] = 127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(250);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
wait1Msec(100);

//move lift back up
motor [drfleft] = -127;
motor [drfright] = -127;
motor [claw] = -127;
wait1Msec(650);

motor [claw] = 0;
motor [drfleft] = 0;
motor [drfright] = 0;
wait1Msec(100);

//put mogo back out
motor [mogo] = 127;
wait1Msec(1000);

motor [mogo] = 0;
wait1Msec(50);
```

The autonomous strategy is to score 22 points by moving forward and taking in the mogo. We then drop the preloaded cone onto the mogo, turn, and put them into the 20 point zone before backing out, scoring us 22 pts.

Problem: After running auton, we move onto driving. However, the robot is not able to move with the joystick right after autonomous round.

Solution: The ~~modes~~ "stop task between modes" was originally set to false. This is part of a pre-autonomous, and when it is set to false, the robot cannot distinguish between user control and auton and runs them both at the same time. So, we set the "stop task between modes" to true and take the auton out of a while loop and thus everything fixed itself.

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Inertia of Wheels 2/20/18

For this year's game of "In The Zone," we wanted to calculate a VEX wheel's moment of inertia of the wheels. With this value, we will know our robot's tendency to resist angular acceleration (the rate at which wheels turn). The mass of a wheel is on its rim, so its moment of inertia about its rotating axis would be $I_{rim} = r^2 m$, where m is mass and r is radius. To determine $I_{wheel}$ experimentally, we used the Parallel Axis Theorem and the dynamics of a pendulum. The Parallel Axis Theorem says that any object rotated about an axis parallel to and a distance, d, from an axis going through the centroid of the object will add an amount equal to $md^2$ to the moment of inertia about the centroid:

$$I_{parallel} = I_{centroid} + md^2$$

If we theoretically swing the mass, m, about the parallel axis like a pendulum, using the torque from gravity, pulling on the mass, then we must show that the period T is related to the distance, d, and moment of inertia.

$$I_{wheel} = I_{parallel} - d^2 m = d^2 m \left(T^2 g/d/(2\pi)^2 - 1\right)$$

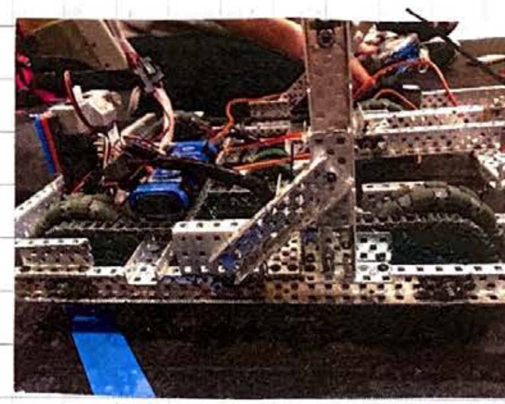
Given: $r_{wheel} = 2\text{ in}$ $\quad d = 2\text{ in} \rightarrow 0.0508\text{ m}$

wheel mass $= 105\text{ g} \rightarrow 0.105\text{ kg}$ $\quad$ Avg. period $T = 0.607\text{ sec}$

$$I_{wheel} = d^2 m \left(T^2/d \cdot 9.8/(6.28)^2 - 1\right)$$
$$= d^2 m \left(0.248T^2/d - 1\right)$$
$$= (0.0508)^2(0.105)(0.248 \cdot 0.668^2/0.07 - 1)$$
$$= 0.00051\text{ kgm}^2$$

$$\sqrt{I_{wheel}/m} = 0.0533\text{ m} = 2.1\text{ in}$$

This value means that the wheel behaves as if the mass is at 84% of the radius of the wheel, and our robot is likely to move with ease and exhibit less resistance to change.



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Coefficients of Friction of Wheel Sizes 2/20/18

In order to justify our wheel selection, we conducted a test to find the coefficients of friction. First, a Squarebot with 4 of the tested was used and locked to prevent spinning. They were placed on a foam tile and each end was lifted up until they start to slip. Taking the tangent of the angle, the results were as follows:

5" (Diameter) Wheel: ~34°
4" (Diameter) Wheel with "Regular" Tire: ~39°
4" (Diameter) Omni-Directional Wheel: ~43°
2.75" (Diameter) Wheel: ~43°

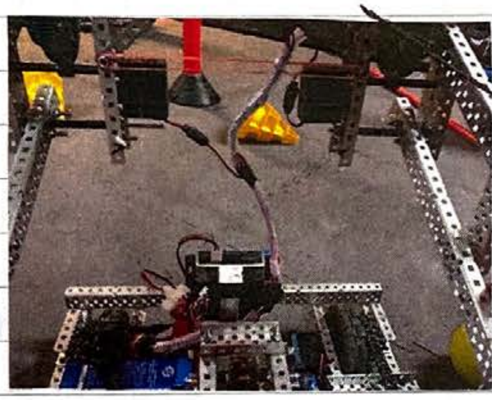
Now taking the tangent of those angles provided the following friction coefficients:

5" (Diameter) Wheel: ~0.675
4" (Diameter) Wheel with "Regular" Tire: ~0.810
4" (Diameter) Omni-Directional Wheel: ~0.933
2.75" (Diameter) Wheel: ~0.933

Based on the results, we are able to explain why we used 4" omni-directional wheels due to their low coefficients of friction. Thus, our likelihood of being pushed around while scoring is relatively low.

Wiring 2/21/18

To justify our arrangement of the wires of our robot, our team goes back to the fact that we dont want to have problems due to disorganization of wires. So, we used spiral cable wraps to enclose and arrange the wires in a way to prevent tanglement.



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Pre-Load 2/21/18

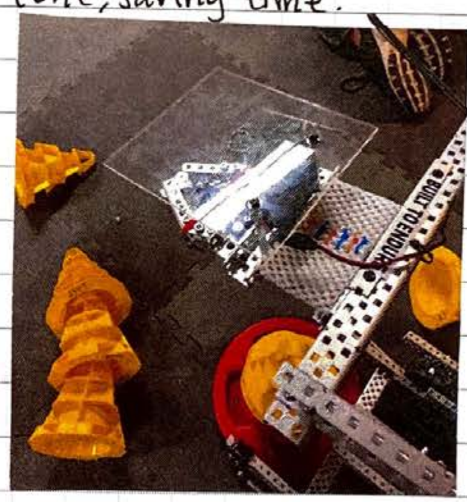
We decided to switch to utilizing the preload after seeing how our robot is able to stack more cones quickly with the preload as opposed to roaming around the field picking up cones while swerving around other robots. We saw the preload as more efficient and likely to offer our team more points during the competition. Strategically, we aim to stack around 8 cones from preloading and set them down in the 10 point, repeating the process for the remainder of the time. However, this really depends on what type of robot we are allianced with.

Problem: Our driver has to set the lift down at the most precise location to be able to grasp the cone at the preloading zone. She also has to open the claw at the right time simultaneously to be able to hold the cone. This is taking up much of the time that could be used to stack other cones or mobile goals.

Solution: We attached a plexiglass piece on top of the claw to aid us in preloading. The plexiglass will help us in the way that our driver does not have to take the utmost concentration in setting the lift and claw at the right spot for preloding. With the plexiglass, the lift stops right on top of the cone, allowing us to immediately grasp the cone, saving time.

HOW This Affected The Code:

With the plexiglass, we can make the lift go farther down without fear of the claw going below the preloading station. We also open the claw for longer so that when going down, it closes perfectly down on the cone.



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## Reliability of the Preload: 2/21/18

Since the code for the preload is timed and we have recently practiced our technique of stacking cones with the preload, we conducted trials to determine the reliability of the preload.

| Trial | # of Cones |
|---|---|
| 1 | 8 |
| 2 | 7 |
| 3 | 5 |
| 4 | 9 |
| 5 | 3 |
| 6 | 6 |
| 7 | 8 |
| 8 | 5 |
| 9 | 6 |
| 10 | 8 |
| 11 | 4 |
| 12 | 5 |
| 13 | 5 |
| 14 | 5 |

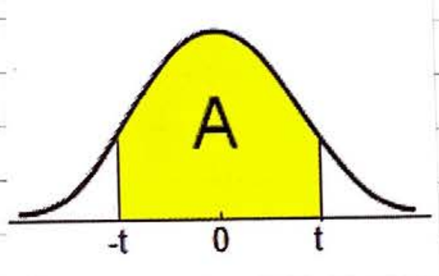
$n = 14$
$\bar{x} = 6$
$\Sigma x = 84$
$S_x = 1.754$
$\sigma_x = 1.690$
$\text{Min}X = 3$
$Q_1 X = 5$
$\text{Med}X = 5.5$
$Q_3 X = 8$
$\text{Max}X = 9$
$IQR = 3$

While the IQR is relatively large, the standard deviation is under two cones, indicating that we can be fairly confident about the reliability of the preload. To further examine the reliability of our pre-load code and stacking method, we used the trial data to construct a 90% confidence t interval. A t-distribution is used instead of a z-distribution due to the small sample size ($n < 30$).

Formula for t-interval for the mean ($\bar{x}$):

$$\bar{x} \pm t \frac{s}{\sqrt{n}}$$

where $\bar{x}$ is the sample mean,
$s$ is the standard deviation
$t$ is the t-dist. value for 0.90C level




t values for the t-distribution where $n = 14$ were chosen so that 5% of the curve's area lies to each side of $-t$ and $t$, creating an area of 90% - the 90% confidence interval. Since our confidence interval is fairly narrow, we can determine that our preload code + stacking method are reliable and do not need to be further modified.

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Pre-Loading Code 2/21/18

```
if(vexRT[Btn8U]==1) {
  //claw closes
  motor [claw] = 127;
  wait1Msec(200);

  motor[claw] = 0;
  wait1Msec(50);

  //chain moves over
  motor[chainleft] = 100;
  motor[chainright] =100;
  wait1Msec(700);

  motor[chainleft] = 0;
  motor[chainright] =0;
  wait1Msec(100);

  //lift moves down
  motor[drfright] = 127;
  motor[drfleft] = 127;
  wait1Msec(400);

  motor[drfright] = 0;
  motor[drfleft] = 0;
  wait1Msec(50);
```

```
  //claw opens
  motor[claw] = -127;
  wait1Msec(300);

  //lift moves up
  motor[drfright] = -127;
  motor[drfleft] = -127;
  motor[claw] = -127;
  wait1Msec(300);

  motor[claw] = 0;
  motor[drfright] = 0;
  motor[drfleft] = 0;
  wait1Msec(50);

  //chain moves back over
  motor[chainleft] = -75;
  motor[chainright] = -75;
  motor[claw] = -127;
  wait1Msec(370);

  motor[chainleft] = 0;
  motor[chainright] =0;
  motor[claw] = -127;
  wait1Msec(400);

  motor[claw] = 0;
  wait1Msec(50);
```

Shown above is the code for our preloading buttons. When button 8U is pressed, the robot will grab the first 3 cones, one with each press of button 8U, and stack them onto the mobile goal. Buttons 8R, 8D, and 8L each stack 2-3 more cones on top of the existing stack (respectively). Different buttons are needed, since the autostacking aspect of the preload code is timed, so the timings need to be adjusted as more cones are added to account for the increased height/distance the lift needs to move.

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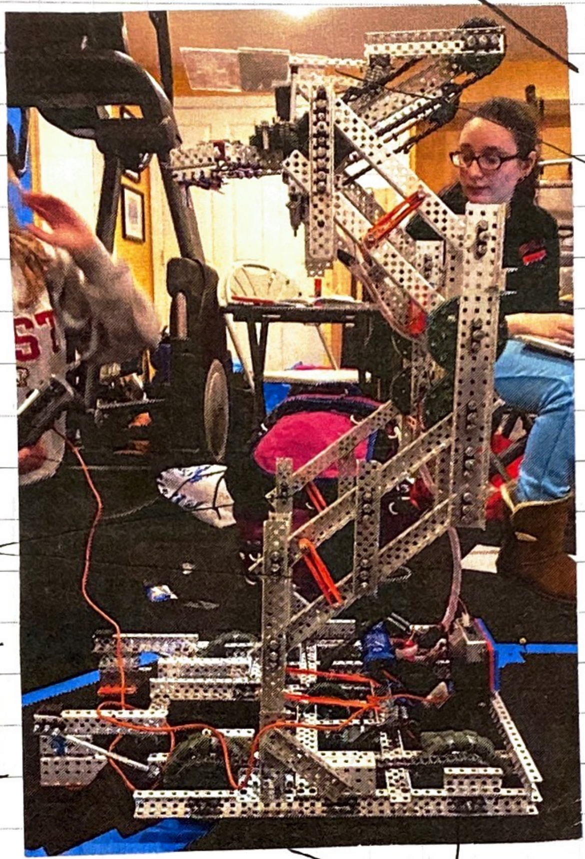


The above labelled picture of our robot serves as an index of its essential parts, allowing us to easily access information about our experience with intakes, lifts, mobile goals, drives, etc. This also provides a quick way for us to strategize and plan designs and ideas for future competitions as we can readily access our past analyses of different structures. We hope that our notebook will serve as a reference for future teams and games if the goal of the game is similar.

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Team Reflection 2/23/18

Entering the robotics room for the first time, we had no knowledge of the build, programming, or even design process. The fact that we were able to transform our small 4-bar into a full-functioning DR4B with autostacking as well as preloading functionality is amazing. And so, whether we qualify for worlds or not, this season was a success of its own. From it, we gained experience, skills, and confidence to come into our senior year and do even better for next year. As the first all-girls team from a predominantly male program, these past couple months gave us the opportunity to prove ourselves to our male counterparts as equally qualified. Getting to worlds would be an amazing accolade for all our hardwork, but more so than anything, we hope to serve as an example that anyone can pursue robotics if they have the drive to learn. We especially want to motivate younger girls to give robotics a try, because we better than anyone know just how few woman actually participate in robotics. Yet, robotics has been a near indescribable experience. To really spread the word and get more girls involved, we not only mentored underclassmen, but delivered a presentation of the basics of robotics and our experience to our school's Women in Science chapter. Of course, we still have a lot to learn, but so far has been an amazing start.

It is only the beginning. We cannot wait to see what the rest of the~~a~~ season and our future as a team has in store for us.


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Night Before States 2/23/18

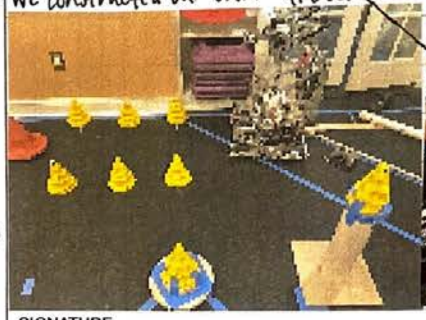
Immediately after school, we met up in the robotics room to start scrimmaging and that was when our problems first began. While driving, our robot appeared to stall for nearly 15 seconds. Our first instinct was to shut down the cortex and switch out the ~~batteries~~ for a fully charged one. When this did not work, we resorted to more thorough methods of resolving the problem. We downloaded the firmware to both the cortex, changed the cortex, keys, joystick, and established a VEX link on everything.

Since the universe loves us, our joystick conveniently stopped connecting to our robot. At 10:19 pm, we traveled to 3 stores, been on hold with Walmart's electronics department for 20 minutes, and went to other people's houses looking for USB cables and any method to make our robot function again. In other words:

Problem: There is disconnection between the cortex and joystick, so our robot does not move. The light for "ROBOT" only came on.

Solution: The joystick and VEXNET lights finally started appearing when we used our remote as a partner joystick with another robot, resetting the cortex, pulling out our wires and one by one testing each to see if they would function separately. When getting to the right/left lift, the connection was lost. We figured out that the lift kept touching the battery expander, which messed with its internal parts, and losing the connection. So, we rotated the cortex to prevent the lift from touching battery expander.

We constructed our own field!



Problem: Lost connection with cortex + joystick!

Solution: Rotate the cortex!

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Day of Competition 2/24/18

Right when we got to the state competition, we immediately went to the pits and practiced driving. However, our cortex was disconnecting, bringing back our problems that we experienced last night. This caused our robot to be immobile whenever we tried to drive. At some times, the cortex would be functionning, but it would immediately disconnect right after. So, we relied on luck. When we went to skills, our auton did not work the 2 rounds. This may have been due to irresponsibility of the fact that we did not push the vex key all the way into the cortex. For the driving skills, we were only able to score 29 points out of those rounds because 1) we forgot to add rubber bands in our mobile goal and 2) our cortex disconnected so we could not drive. After these unfortunate events, we were very discouraged about the rest of the competition. Not wanting to give up, we went to the pits and practiced our autons before qualification rounds. Before each round, we met up with our alliance and strategized about what each of us would do in terms of scoring as well as what ~~#~~ our robots are capable of achieving during autonomous and drive periods. In the qualification rounds we won 6 matches and lost 2 matches. It was overall a very satisfactory competition, but the reason why we lost the 2 matches was because the drive team experienced miscommunication regarding what we should score during the drive period. For instance, before going into the drive box, our team collectively agreed to stack 2 cones on a mobile goal into the 20 point zone and the rest of the mobile goals with cones stacked into the 10 point zone. However, during one of our matches, the drive team disregarded this and went for 3 cones stacked on the mobile goal. As a result of the force put in to push the mobile goal, we got stuck in the 10 point zone, unable to move or score for the rest

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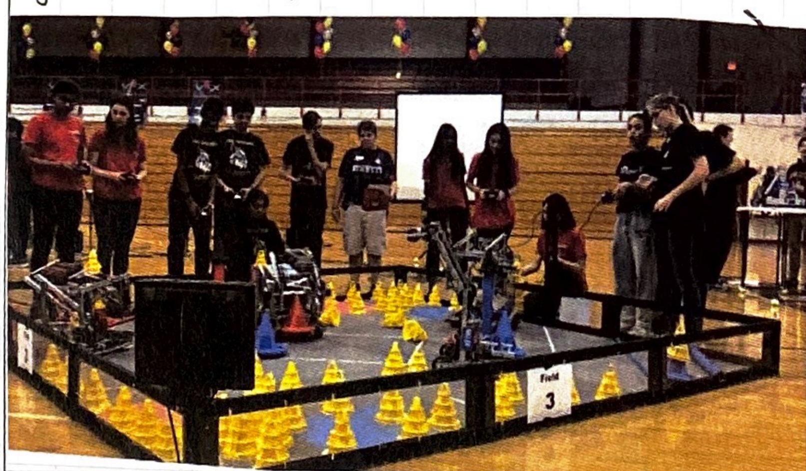
of the match. We considered our judges' interview to be pretty successful. As a team, we discussed and finalized what each member will say during the interview. We were sure to mention and talk about our build process, programming, problems we encountered, our mentoring experiences, and our notebook. We paid special attention to our discussion on our notebook for the judges because we wanted to get a shot at the design award. For instance, we talked about how we had to designate a section of justification on why we chose each aspect of our robot to serve as a reference point for us and future teams.

We concluded the qualification rounds winning 6 rounds and losing 2, ranking 4th in the competition: our WP was 12, AP was 80 (which was the highest in the competition), SP as 430. We were an alliance captain with teams 765X and 9708A, however, we lost 61-87 the first round and lost again 51-121. Despite losing, we were still proud of our team and performance for making it this far. We received a great surprise at the awards ceremony: we won the design award! It was unexpected since there were so many other great teams, but we were downright happy to receive such an award. This award now qualifies us for worlds! There is no doubt that our hard work and diligence paid off and we can look back from last year to see how much we grew and improved. We couldn't be more prouder and thankful.





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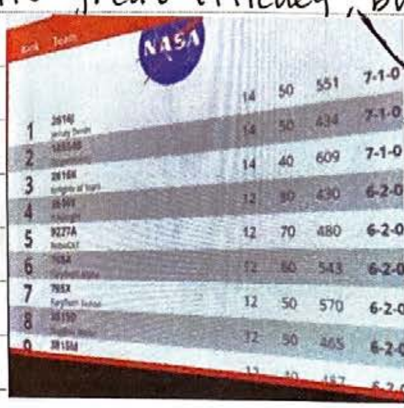
Reflection of State Competition (2/25/18)

Overall, our performance at the state competition was very satisfactory. However, we know there were things we could definitely improve upon as a team. One aspect is being immaculate. That is, making sure every component of our robot is intact, working, and secure. There were instances at the competition where, due to our carelessness, we did not put rubber bands to our mobile goal lift, which is paramount for picking up the mobile goals. Without them, the robot cannot pick up the mobile goals, thus the match would be pointless. Another example is making sure the VEX key is inserted completely into the cortex while the battery and controller batteries are fully charged. These little but crucial facats of our robot must be double checked as they make all the difference in success and so to ensure our full potential towards the competition. Additionally, we are aware that our intake may not be the most advantageous. The goliath intake has always been an idea at the back of our minds, but because of insufficient time before the state competition, we were unable to switch to one. We also observed its great capability and potential for picking up cones during the competition as it was a popular intake among teams. As a result, we want to change our claw to a ~~goliatch~~ goliatch for the world championship. Also, since we are very familiar with timed autons, we decided to stick with them rather than switching to sensor autons. We understand its great efficacy, but we will resume working with timed

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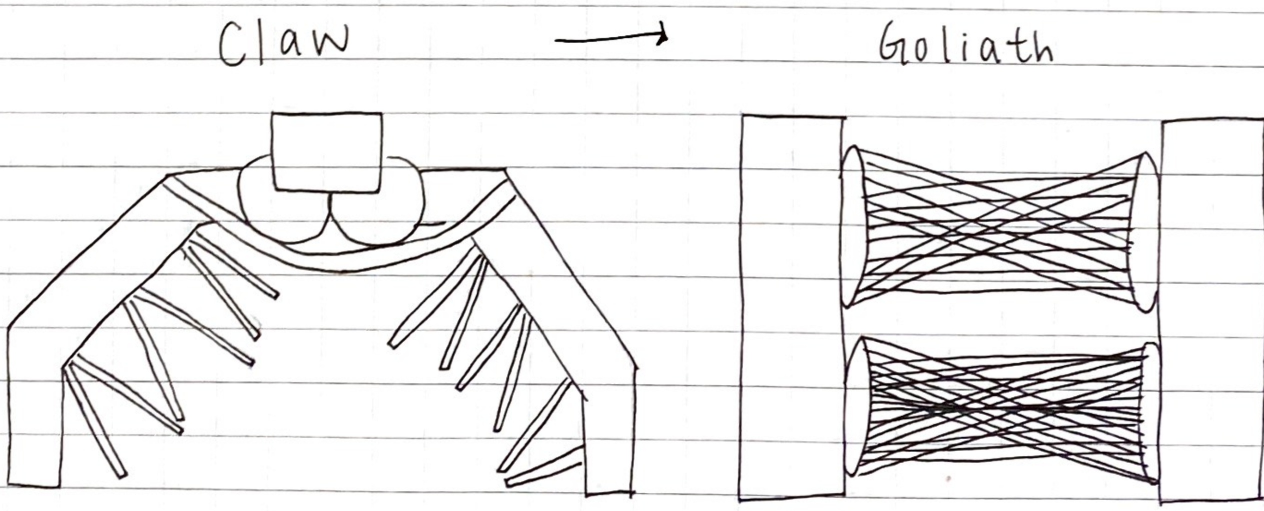
actions. During the judges' interview, our team rehearsed what we were going to say multiple times, but at the last minute, we were told we were only getting about 5 minutes. So, when we went into the interview, not all of us were able to say what we practiced. For the future, each member should cut down their lines to focus on the main points and ideas for others to say their parts. From this competition, we learned to stay cautious of other teams. As qualification rounds were coming to an end, many teams came up to us telling us to choose them for an alliance or to not choose them. For some, this was a strategy. By telling our team to not pick them either because their robot broke or some other problem arose, that specific team could be aiming to be chosen for another different alliance. We found ourselves uncertain on who to trust and believe since we did not want to be deceived. Consequently, we learned to be cautious and to do our research on teams before making decisions and throughout the competition because one never knows the outcome of a competition. Our team should work on networking to establish amiable and compatible relations with other teams so that for future tournaments, teams will recognize us for our integrity and performance.

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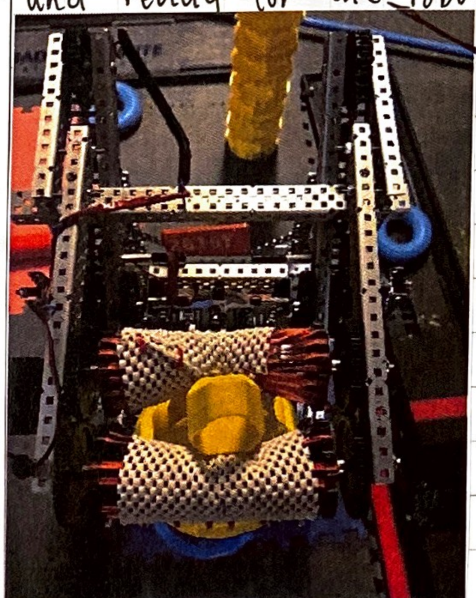
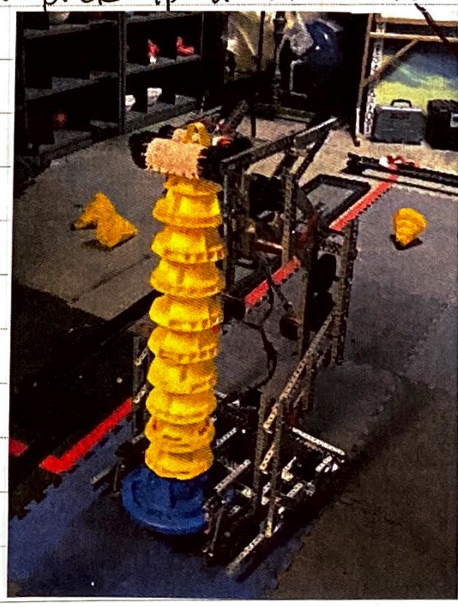
Constructing the Goliath 3/11/18

We changed our intake to a goliath as it is a more efficient and faster intake than our claw. It is also primarily seen and used among the top tier teams, so there must be success in utilizing this type of intake.

To build the goliath off of the chainbar, the mass had to be centered to keep the robot's alignment. We utilized a 1 to 1 (1:1) gear ratio and put the goliath at a speed of 20. Off of the sprockets, we attached rubber bands in a straight line across. We chose this arrangement as opposed to a diagonal pattern because its success in picking up the yellow cones is the same as the ~~diagnal~~ diagonal arrangement. Also, because the gears of the goliath will be moving (one forwards and the other backwards), the goliath design with rubber bands going across will be able to successfully pick up and grasp the cones. Then, we added friction padding to further help hold onto the cones.

We added to the design a body of stand offs with the purpose of setting toppled cones straight. The design consists of 5 stand offs with a c-channel between them. This structure will allow the robot to stick into the depressions of the cone and move it so the cone is set straight and ready for the robot to pick up after it is fallen.





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Field Building 3/18/18

We decided to build our own field, which is handmade, at one of our member's house for our own conveniency and improvement. With our own field to access anytime, we can work on our autons with precise measurements, and more importantly, our driving. This is beneficial to our team because we can access a field outside of school to replicate the real competition. We gathered wood pieces to match the length of the sides of the field, foam place mats for the ground of the field, stationary goals made from a cone and wood cylinder, and PVC pipes for the 10 point and 20 point zones. We utilized colored tape for the markings on the field, and lastly added the yellow cones and mobile goals onto the specific positions on the field. We also added wood pieces for the preloading zone.

An observation we found was that our robot is much quicker and productive during a dual control than a single controller. So, we are switching to a dual driver system: one controls the drive while the other controls the lift and intake. For instance, the drive controller can position the robot to other cones/mobile goals simultaneously as the lift + intake controller is picking and stacking cones.

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Scrimmage Rounds 3/25/18

Today, we practiced multiple matches to see how many points we are able to score within the time frame, and to see if there are any problems regarding our robot during the match. We also developed strategies like which mobile goals and yellow cones to go for. Because the rules allow, we found that we can tip over the opposing mobile goals to slow down our opponents. We scrimmaged with team 2616E, without running the autonomous periods. The following chart depicts the amount of points 2616Y and 2616E were able to score together:

| Round # | # of points |
|---|---|
| 1 | 89 |
| 2 | 102 |
| 3 | 106 |
| 4 | 91 |
| 5 | 93 |

* The data does not account for autonomous points or high stack points.

The amount of points we are able to score now is evidently higher than ~~w~~ the amount scored with our previous claw. The guliath offers us ease in control, such as the fact that we only have to glide over the cones to pick them up. The material of the rubber bands and the added friction padding guarantees that we successfully hold up the cones for stacking. Unlike the claw intake, we rarely have to be sure that the cone is all the way in our intake.

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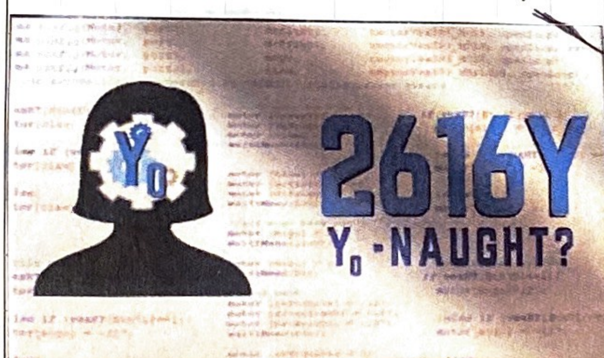
Networking 3/31/18

In order to reach out to other teams, we knew we had to resort to networking techniques. Thus, we created a website, business card, and a team logo. Through these resources, we put information about our team and robot. For instance, on our website, we have background information pertaining to each of our members, detailing how we got into robotics. We also have team statistics like the number of events we participated in, our best ranking, the maximum number of cones we can stack as well as the maximum amount on stationary goals. We included the number of motors on each part of our robot and gear ratios. Most importantly, we included pictures of our robot to give our viewers a visual representation. We have the link of our website through a QR code on our business cards along with a basic and concise list of what our robot is capable of doing in terms of scoring. We will hand out these business cards and other goodies to teams so that other teams are aware of 2616Y, and for a possible consideration for alliances. In each of our networking vessels, we have our team logo, so that teams can remember us through an image, since there will be so many teams at the world championship. We created our logo in this specific fashion because we think our all-girls team is an important and great characteristic for our team. That is, we want others to know we are a suitable choice and experienced team despite our gender that is scarcily represented in this field of science.



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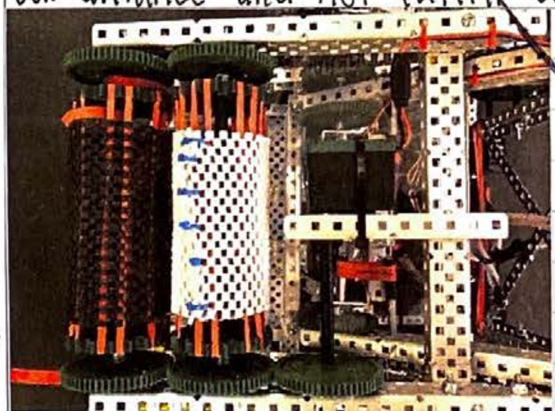
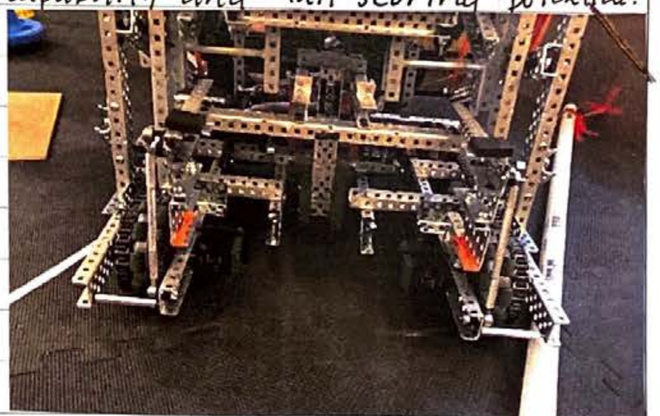
Design Additions 4/4/18

We removed the body of standoffs from the intake. The reason was that the structure was counterintuitive to what we expected for it to accomplish. That is, it took more time for us to use the body of standoffs to set the cones straight and upright. Instead, we could easily set toppled cones upright utilizing the goliath structure. That is, we can move the goliath inwards (as if it were picking up a cone) on the bottom edge of the toppled cone. As a result, the fallen cone will be upright for the robot to pick up. Because of this method, we took off the standoff design as it served no extra purpose.

Additionally, we added plexiglass on top of our intake to prevent cones getting stuck on top. We had this problem when moving the lift down to pick up cones, but due to poor aim, there were times when cones would be inserted at the gap near our intake instead of the goliath. With the plexiglass, cones will not get caught where they are not supposed to. Similarly, we added standoffs to the front of the drive on both sides for the same reason of preventing cones getting stuck. We want to prevent this problem because it prohibits us from scoring other cones when there is another cone already touching the robot. Consequently, time passes and is wasted since we cannot score points. It would be a disaster if such a problem occurred during the competition because we would let down our alliance and not fulfill our robot's capability and full scoring potential.





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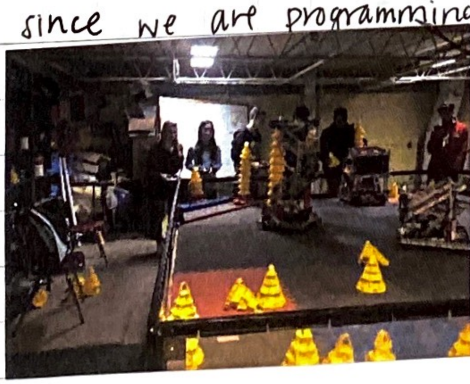
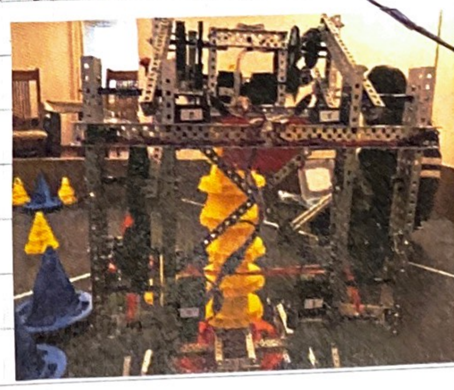
Lift Motors 4/12/18

While scrimmaging with other 2616 teams, we noticed a drastic difference between our robot and their robots. The difference was that our lift was slower than other teams'. This served as a major setback since the lift allows us to pick up and stack cones, which are a paramount component of our scoring. While other teams were on their 8th or 9th stacked cone, our robot was only on its 4th or 5th. This shows that other teams are capable of stacking twice as many cones during the same amount of time. With our current lift, our chances of scoring high are slim because we take a long time to stack cones. Our solution to fix this problem is to add motors to the lift to provide the lift with a speed boost. As a result, the robot will be able to stack cones at a faster speed, thus resulting to more cones stacked in the 1 minute and 30 second drive period, and possibly during the 15 second autonomous period.

Problem: The lift is performing at a drastically slow pace compared to other Worlds-qualified teams. Because of our slow lift, we are unable to stack as many cones and end matches with a high score.

Solution: By adding extra motors to the lift, the lift can move at a faster speed. We added 2 motors, since there are two sides to the lift, so that the lift moves faster evenly. We used a y-cable for the motors since we are programming paralleled motors.





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The Robot's Center of Gravity 4/15/18

Because our robot has a relatively tall lift, maintaining stability ~~is~~ still remains as one of our concerns. Although our robot has not tipped over at the state competition, we know it is a probable occurrence since there were a few times the robot tipped over when we practiced through scrimmages or individually. Maintaining stability is linked to the robot's center of gravity, and because the robot experienced new additions, like motors, standoffs, ~~and~~ plexiglass, and the goliath, the weight of the robot changed. As a result, the robot's center of gravity changed, too.

1 Yellow Cone's Effect:

Robot = 17 pounds    1 yellow cone = 0.26 pounds

% of change equation = $\left(\frac{0.26 \text{ lbs}}{17 \text{ lbs}}\right) \times 100$

$= 1.529\%$

The weight of 1 yellow cone has a 1.529% effect of weight to the robot's speed.

Maximum Amount of Yellow Cones (11) Effect:

Robot = 17 lbs    11 cones = (0.26 lbs)(11) = 2.86 lbs

% change = $\left(\frac{2.86 \text{ lbs}}{17 \text{ lbs}}\right) \times 100$

$= 16.824\%$

The weight of 11 yellow cones has a 16.824% effect of weight to the robot's speed.

11 Yellow Cones + Mobile Goal Effect:

Robot = 17 lbs    11 cones + mobile goal = 2.86 lbs + 4 lbs = 6.86 lbs

% change = $\left(\frac{6.86 \text{ lbs}}{17 \text{ lbs}}\right) \times 100$

$= 40.353\%$

The weight of 11 yellow cones and mobile goal has a 40.353% effect of weight to the robot's speed.

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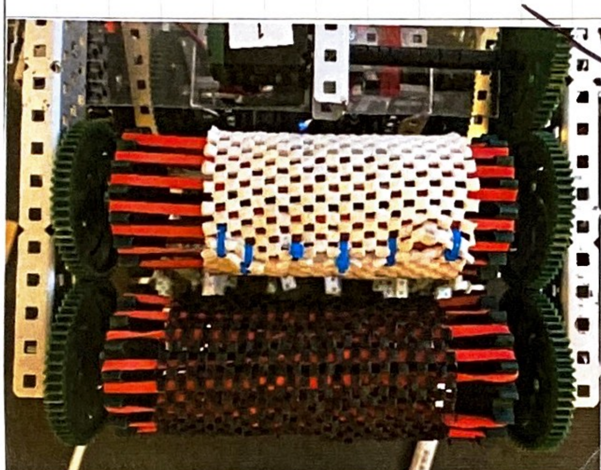
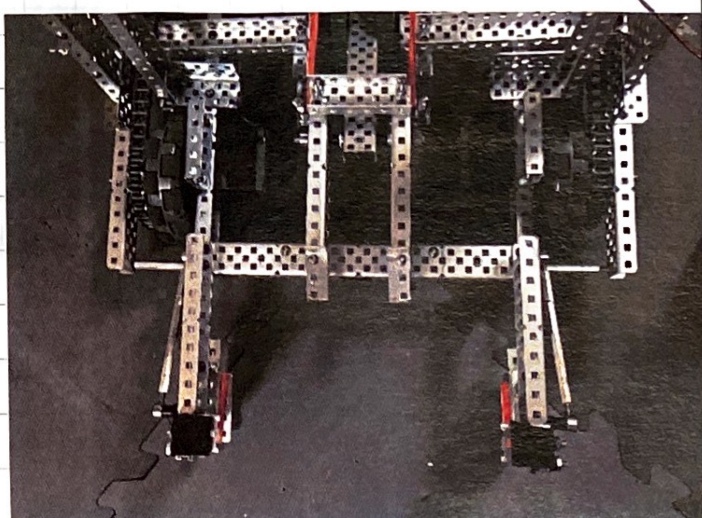
The robot's center of Gravity (cntd.) 4/15/18

Because our final goal in each match is to stack 11 yellow cones onto the mobile goal. Then, the robot should place the mobile goal with the stacked cones into the 10 point zone. However, a percent change 40.353% is incredibly high. Our robot will experience a reduction in speed with the great weight of 11 stacked cones, and thus significant instability. So, the mobile goal lift can step in as an anti-tip structure. Additionally, by setting the goliath down on the topmost cone on the stack, we can be ~~gat~~ guarenteed more stability and prevent the robot from falling over. We must also be cautious by making sure we put the lift down before moving forward/backward quickly.



← Presented here is our intake, the goliath. It is a 1:1 roller intake, and with its composition of rubber bands and friction padding, cones are secured from the instability from the robot's center of gravity. The goliath ensures that the robot is less likely to tip over when there is a high number of stacked cones.

Presented on the right is the → mobile goal lift. By grabbing and moving the mobile goal with the stacked cones towards the center of the robot and drive, we can hope that the robot will be less likely to tip over. In this way, our robot can function as somewhat of an anti-tip system.



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Addition of 2 Motors to the Lift 4/15/18

Torque Load = $\frac{(\text{Current} - \text{Free current}) \times \text{Stall Torque}}{(\text{Stall Current} - \text{Free current})}$

Torque Load = $\frac{(2\text{ Amps} - 0.1\text{ Amps})(1\text{ N-m})}{(3\text{ Amps} - 0.1\text{ Amps})}$

Torque Load = $\frac{(1.9\text{ Amps})(1\text{ N-m})}{(2.9\text{ Amps})}$

Torque Load = 0.655 N-m

Torque Load = (0.655 N-m)(4 motors) = 2.62 N-m

Our robot can handle a torque load of 2.62 N-m based on the 4 motors we have attached to our lift.

Torque Load = Force x Distance

Force = (Mass) x (Acceleration Due to Gravity)

Force = (2.86)(9.81) = 28.0566
↳ Mass of 11 cones

Torque Load = (28.0566 N)(0.254 m)
= 7.1263

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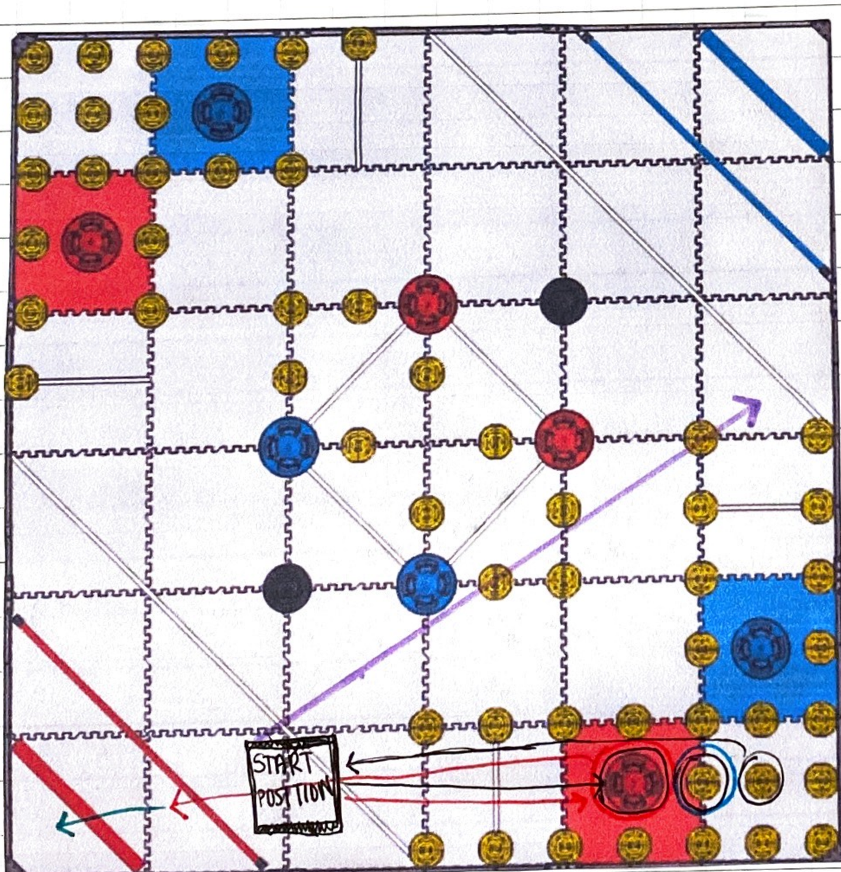
<u>New Autonomous Programs</u> 4/17/18

After seeing the variety of robots and their autonomous programs at the states competition, we decided to create multiple autonomous programs to give ourselves more options when strategizing how to win the auton perod with our alliance team. We created 9 autonomous programs - an 11 pt (scores in 5 pt. zone), a 12 pt, 14 pt (scores in 10 pt. zone), and a 22 pt (scores in 20 pt. zone). These autons were made for the left and right side of the field, allowing us to be able to adjust to most situations in matches and account for other autons. We also created a blocking auton to prevent an opponent's robot from scoring points in the zones with a mobile goal.

<u>Autonomous Programs Overview</u>




→ this arrow represents the path taken by the <u>11 pt auton</u> - drops the preload cone onto the mobile goal & picks up two more cones - moves into 5 pt. zone

→ this arrow represents the path taken by the <u>12 pt auton</u> - drops the preload cone onto the mogo - moves into 10 pt zone

○ the <u>14 pt auton</u> follows the same path as the 12 pt, but picks up & drops this cone

→ the <u>22 pt auton</u> follows the same path as the 12 pt, but travels this additional distance to score in 20 pt zone

→ the <u>blocking auton</u> follows this path, preventing the opposing team from reaching their mobile goal

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## Right Side Autons → 11pt

```
//move forward
motor [leftdrive] = 127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(175);
```

done to pick up the third cone

controls the motors on the right side of the drive

```
motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
wait1Msec(50);

//lift moves back up
motor[drfright] = -127;
motor[drfleft] = -127;
motor [claw] = 20;
wait1Msec(100);

motor [claw] = 20;
motor[drfright] = 0;
motor[drfleft] = 0;
wait1Msec(50);

//chain moves back over
motor [claw] = 20;
motor[chainleft] = -85;
motor[chainright] = -85;
wait1Msec(300);

motor [claw] = 20;
motor[chainleft] = 0;
motor[chainright] =0;
wait1Msec(50);

//lift moves down and claw opens
motor[drfright] = 100;
motor[drfleft] = 100;
motor[claw] = 127;
wait1Msec(950);
```

the third cone is dropped onto the mobile goal

```
motor[claw] = 127;
motor[drfright] = 127;
motor[drfleft] = 127;
wait1Msec(60);

//lift moves up
motor [claw] = 20;
motor[drfright] = -127;
motor[drfleft] = -127;
wait1Msec(650);

motor [claw] = 20;
motor[drfright] = 0;
motor[drfleft] = 0;
wait1Msec(50);
```

```
motor [claw] = -127;
motor[drfright] = 100;
motor[drfleft] = 100;
motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(100);
```

As the lift moves up, the robot turns in order to use the 15sec autonomous period efficiently

```
motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
motor [claw] = -127;
motor[drfright] = -127;
motor[drfleft] = -127;
wait1Msec(150);

motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
motor[claw] = 0;
motor[drfright] = 0;
motor[drfleft] = 0;
wait1Msec(125);

motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(295);

//chain moves over
motor[chainleft] = 100;
motor[chainright] =100;
motor [claw] = 20;
motor [leftdrive] = -127;
motor [frontright] = -127;
motor [backright] = -127;
wait1Msec(700);

motor [claw] = 20;
motor[chainleft] = 0;
motor[chainright] =0;
motor [leftdrive] = -127;
motor [frontright] = -127;
motor [backright] = -127;
wait1Msec(200);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
wait1Msec(100);

//lift moves back down
motor [claw] = 20;
motor[drfright] = 127;
motor[drfleft] = 127;
motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(300);
```

lines in yellow highlight have the signs of their values switched for the left side autons in order to account for the different direction of the turn (ex. 127 → -127 for the left side)

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12 pt auton (right side)

```
//turn
motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(970);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
wait1Msec(100);

//move forward
motor [leftdrive] = 127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(270);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
wait1Msec(100);
```

The main difference b/w the 11pt and 12pt auton is the turn and moving forward timings, as the 12pt auton has to score in the 10 pt zone. The turn is also done more simply, since it doesn't have to move the lift at the same time.

~~11~~ 22 pt auton (right side)

```
//turn
motor [leftdrive] = -127;
motor [frontright] = 127;
motor [backright] = 127;
wait1Msec(860);

motor [leftdrive] = 0;
motor [frontright] = 0;
motor [backright] = 0;
wait1Msec(100);

//move forward
motor [leftdrive] = 127;
motor [frontright] = 127;
motor [backright] = 127;
motor [claw] = -127;
wait1Msec(700);

motor [leftdrive] = 127;
motor [frontright] = 127;
motor [backright] = 127;
motor [claw] = -127;
motor [mogo] = 127;
wait1Msec(800);

//move back
motor [leftdrive] = -127;
motor [frontright] = -127;
motor [backright] = -127;
motor [mogo] = 0;
wait1Msec(600);
```

The 22pt auton moves in the same way as the 12pt auton, but since it needs to move into the 20pt zone & drop the mogo in & move out quickly in order to avoid being stuck, the turn & moving timings are different.

Blocking Auton

```
task autonomous()
{
    //move back
    motor [leftdrive] = -127;
    motor [frontright] = -127;
    motor [backright] = -127;
    motor [mogo] = 0;
    wait1Msec(4000);

    motor [leftdrive] = 0;
    motor [frontright] = 0;
    motor [backright] = 0;
    wait1Msec(50);
```

The blocking auton simply moves. That is, to play ~~moves~~ defense in the autonomous period, our robot can move backwards for 4 seconds to the opposing team's side. Our robot will be in the way of other team's autons for their robot. This is advantageous for our team because we can prevent opposers from scoring points.

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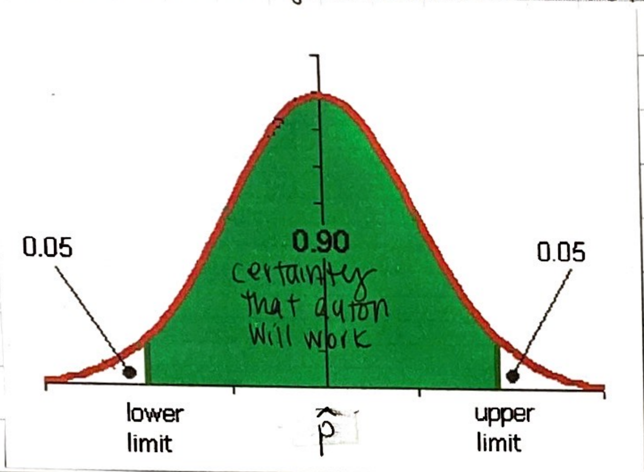
# Reliability of Autonomous Programs 4/17/18

We conducted many trial runs to test the reliability of our autons, since we use timed autons so distances can vary slightly based on battery power and other factors. We used the trial data to construct a 90% confidence interval for the reliability of each auton using the formula for a Z interval for proportions




$$\hat{p} \pm z \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

z-score for 90%

proportion of successes

sample size

The z-score for a 90% confidence interval is $z = 1.645$ (at this $\pm z$ value, there is a bounded area of 0.90 under the normal bell curve)

The 20pt left-side auton & 11pt left-side auton had success rates of 0.7, or 70%

$$0.7 \pm 1.645\sqrt{\frac{(0.7)(0.3)}{10}}$$

$= (0.4616, 0.9384)$

We can be 90% confident that the auton will work b/w 46.16% to 93.84% of the time.

The 20pt right-side auton had a success rate of 0.8, or 80%

$$0.8 \pm 1.645\sqrt{\frac{(0.8)(0.2)}{10}}$$

$= (0.5919, 1)$

We can be 90% confident that the auton will work b/w 59.19% to 100% of the time

The 14pt left-side, 12pt left-side, & 11pt right-side autons had success rates of 0.9 or 90%

$$0.9 \pm 1.645\sqrt{\frac{(0.9)(0.1)}{10}}$$

$= (0.74396, 1)$

We can be 90% confident that the auton will work b/w 74.4% to 100% of the time

The 14pt right-side and 12 pt right side autons had 100% success rates ☺

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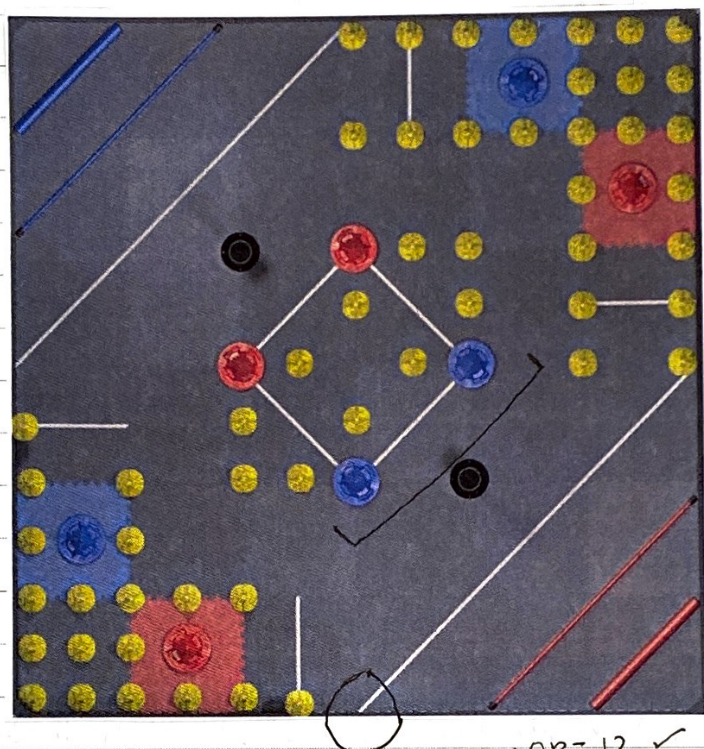
Practice Rounds 4/19/18

In order to practice driving and gain a better understanding of our performance, we ~~tri~~ did 15 1min45sec rounds to see how many points we could score individually. The results are shown below:

| Trial | # of Points |
|---|---|
| 1 | 73 |
| 2 | 76 |
| 3 | 93 |
| 4 | 91 |
| 5 | 76 |
| 6 | 84 |
| 7 | 74 |
| 8 | 76 |
| 9 | 86 |
| 10 | 66 |
| 11 | 84 |
| 12 | 84 |
| 13 | 76 |
| 14 | 74 |
| 15 | 91 |



The selected areas are generally the areas we stacked and went for on the field.

small $s_x$ = good!

IQR = 12 ✓

$\boxed{\bar{x} = 80.2\bar{6}}$ $s_x = 7.905$ $Q_1 x = 74$ Median = 76 $Q_3 x = 86$

As seen in the data above, there were some rounds that resulted in more points than others. The range was 27, meaning that by employing the correct strategy, the difference in points scored can be by 27 points. It is therefore imperative that we select the best strategy wisely. We noticed that certain strategies yielded about the same number of points. So, during competitions, we must focus on adhering to the best strategy. The addition of the goliath and the dual driving system has increased our avg. pts scored by about 52 points (prev. calc - 28.4pts)

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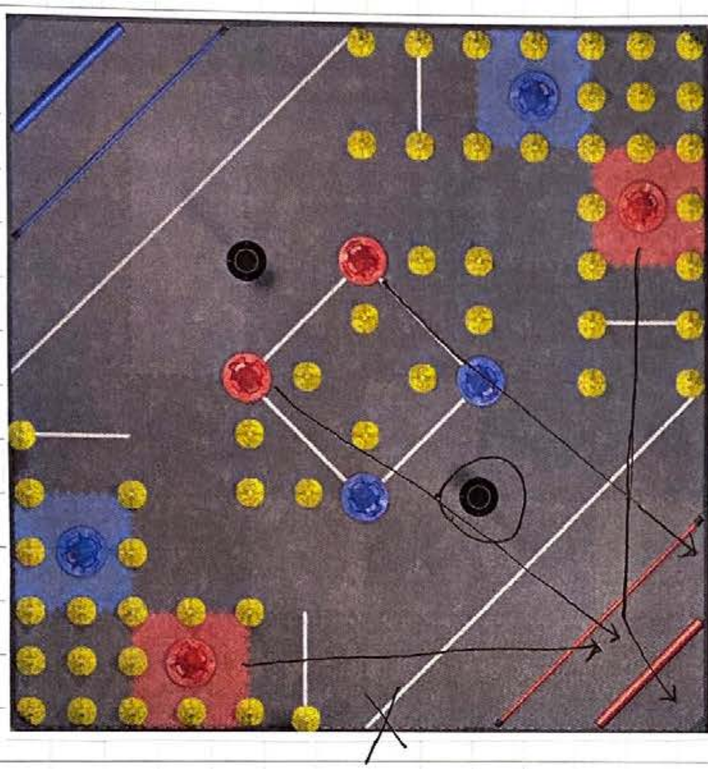
Strategy 4/19/18



We will set the mobile goal in the parking zone to the 20 point zone from autonomous or in the drive period.
& Then, we will place the mobile goals in the center to the 10 point.

If time allows, we will reverse stack onto stationary.
We will ~~not~~ utilize the match-loads in this strategy.

One of our main strategy to implement involves the 10 point zone, 20 point zone, and the matchload. We first plan to drive to the mobile goal directly straight from the zones to the right. After picking it up, we will stack around 9-10 cones from around the mobile goal on the field, and finally place it in the 10 point zone. Then, we plan to pick up another mobile goal and stack 9-10 cones from the matchload. Next, we place the stacked cones into the 10 point zone. However, this is considering that we have stacked 3 ~~mo~~ cones on a mobile goal into the 20 point zone. If time allows, we plan to park to gain the extra 2 points. Also, if we can, we will reverse stack onto the stationary goal. Another thing to consider is if there are more efficient and overall better stategies we observe or come up with at the time of competition.

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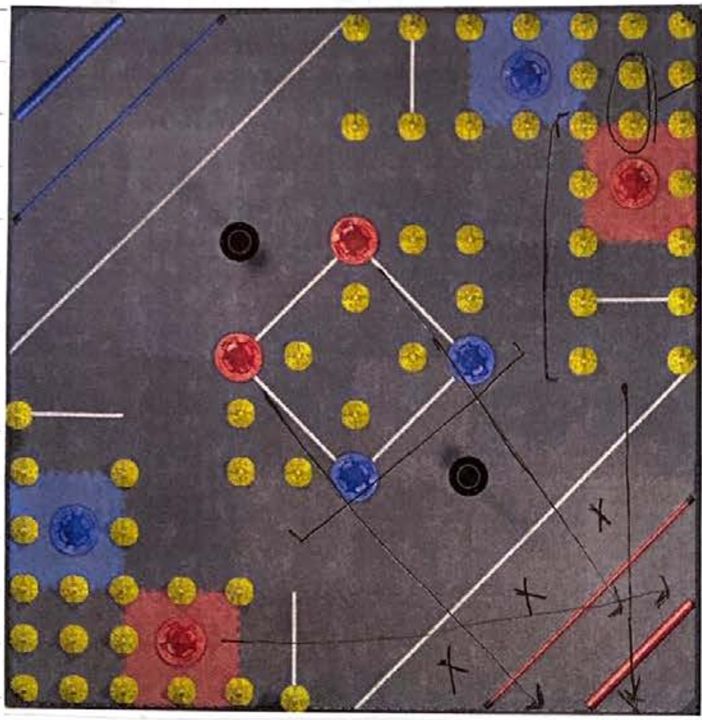
Strategy (cntd.)



We plan on using these 2 cones along with our preload for antunomus period.

In this stategy, we will not use the matchload. Instead we will stack solely from the cones on the field. Depending on the match and how it plays out, we will set the mobile goal into 5 point zone for high stack points. We will stack onto stationary too.

Our second strategy is to stack with the cones already placed on the field. We would carry out this strategy if our alliance needs to use the matchload. With a mobile goal and 3 stacked cones on it, we will have this in the 20 point zone. However, if we are unable to accomplish this from autonomous, we must do this first in the drive period, so that we can work from the inner zones out. Placement of the mobile goals in the 10 point zone are also crucial. We aim to set the mobile goals on the side first, working our way to the opposite side. In this way, we will not have any problems with space in setting mobile goals down. We must consider high stack points as well. That is, there may be instances in which we may score more points by placing mobile goals in the 5 point zone than in the 10 point zone due to extra high stack points. If time allows, we will stack up to 4 cones onto the stationary, and possible get highest stack on stationary.

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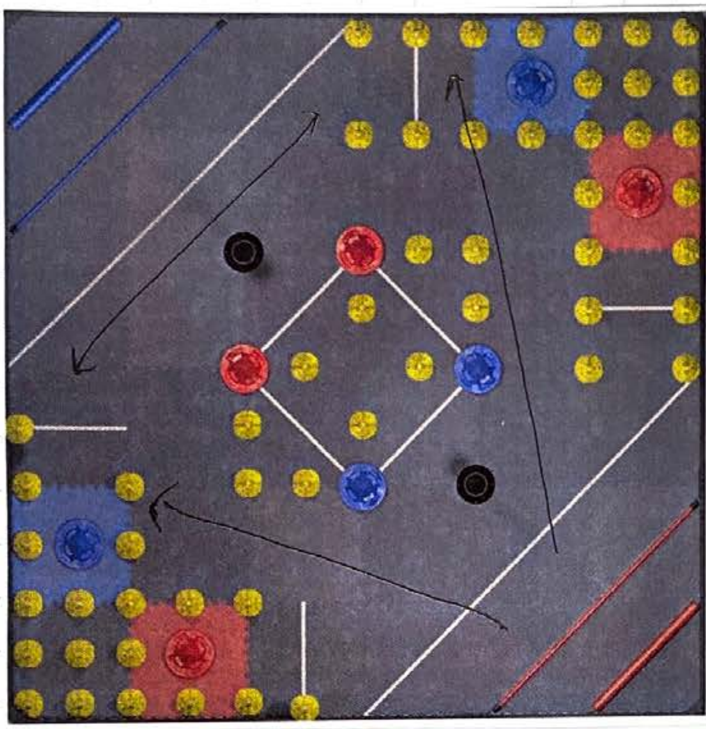
Strategy (contd.)



The indicated arrows show where we will drive to during a match where we play defense. The arrow to the right depicts the path our robot will take during autonomous to hinder our opponent's auton. The remaining 2 arrows represent where our robot ~~to~~ will be during driving while staying clear from the opponents' zones.

Another strategy to keep in mind with is playing defense. There are many unforeseen instances where we may have to play defense, such as a disconnected cortex, fallen-off rubber bands from the mobile goal lift, or a cone stuck in our robot, unallowing us to score points. In turn, we must act so that our opponents cannot score as many points as well. We can do this by tipping over the opponents' mobile goals, making it difficult for them to pick up the mobile goals, which takes up time and results in lesser points scored. We can also be in the pathway of the opposing team, so they can't reach mobile goals quickly or stack efficiently. However, we must be cautious in performing this defense mechanism so as to not get disqualified. Our drivers must be careful when near the opponents' zones.

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Scouting 4/20/18

When we get to worlds, we want to conduct good and thorough research on the teams in our division. This will be useful during qualification rounds since we will have robot statistics on our alliances and opponents. It will also be useful in the case where we do become alliance captains and must select teams.

We set up our table by separating and collecting information according to Team, Drive type, Lift type, Intake type, ~~5~~ if they are capable of stacking on stationary, the zones they can reach, and autonomous, which includes how many autons and what their autons are able to accomplish. Lastly, we have an "other" column for any additional comments that are deemed necessary to know.

To collect the data and information, we first looked on VEX via to find teams' statistics or on RobotEvents. If we could not find information that we need, we will have 3 members from our team to scout. They will go around the pit (Engineering division) and find the teams we need information on and they will ask the necessary questions. Not only will we gain information, but we will also establish relationships and connections with teams. We will give teams our buttons, business cards, and earphones with our team's name on them to make ourselves known, which is essential to any competition.

| TEAM | DRIVE | LIFT | INTAKE | STATIONARY | ZONEZ | AUTONS | OTHER |
|---|---|---|---|---|---|---|---|
| 2S | | | | | | | |
| 12F | | | | | | | |
| 39W | | | | | | | |
| 66A | | | | | | | |
| 127X | | | | | | | |
| 162A | | | | | | | |
| 177V | | | | | | | |
| 231X | | | | | | | |
| 306X | | | | | | | |

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Scouting (cntd.)

| TEAM | STATES RECORD | AP @ STATES | RANK @ STATES | QUALIFIER | OTHER |
|---|---|---|---|---|---|
| 2S | 8-1 | 50/90 | 2 | tourney champs | 99.4 sample avg |
| 12F | 2-6 | 40/80 | 47 | | goliath |
| 39W | 1-5 | 0/60 | 47 | tourney finalist | |
| 66A | 6-0 | 40/60 | 1 | tourney champs | 96.7 sample avg |
| 127X | 6-1-1t | 40/80 | 7 | tourney finalist | |
| 162A | 8-2 | 60/100 | 7 | tourney semis | |
| 177V | 8-0 | 40/80 | 2 | tourney champs | |
| 231X | 5-3 | 60/80 | 7 | tourney finalist | 72.3 samp avg |
| 306X | 3-1-1t | 10/50 | 11 | | |
| 323G | 4-3 | 20/70 | 25 | tourney semis | 3rd @ us open (9-1) |
| 355M | 5-3 | 20/80 | 14 | tourney finals | |
| 363A | 4-3 | 20/70 | 21 | tourney semis | 80.4 samp avg |
| 507D | 2-5 | 20/70 | 42 | design | 63.3 samp avg |
| 574F | 6-1 | 40/70 | 5 | tourney finals | |
| 624H | 6-2 | 50/80 | 7 | | |
| 666X | 7-1 | 30/80 | 7 | tourney semis | |
| 824Z | 4-3 | 30/70 | 17 | tourney semis | |
| 929X | 7-0 | 60/70 | 1 | tourney finalist | 90.25 samp avg |
| 1010N | 4-4 | 30/80 | 24 | tourney champs | |
| 1045B | 4-5 | 20/90 | 28 | tourney champs | |
| 1138B | 4-3 | 30/70 | 19 | | |
| 1264D | 4-2 | 20/60 | 18 | semis | |
| 1320C | 3-3 | 30/60 | 27 | excellence | |
| 1429B | 2-6 | 0/80 | 37 | semis | |
| 1492Y | 3-4 | 40/70 | 24 | semis | |
| 1588D | 2-4 | 20/60 | 18 | champs | 75.9 samp avg |
| 1784Z | 8-2 | 50/100 | 8 | semis | |
| 1961N | 2-3-1t | 30/60 | 42 | finalists | 86.5 samp avg |
| 1970K | 8-2 | 70/100 | 10 | excellence/champs | 117.75 samp avg |
| 2019F | 6-1 | 60/70 | 6 | design | 78.45 samp avg |
| 2131M | 6-1 | 60/70 | 2 | finalists | 109.6 samp avg |
| 2235A | 5-3 | 50/80 | 4 | champs | 95.8 samp avg |
| 2316A | 4-4 | 20/80 | 8 | champs | 89.6 samp avg |

Above is a sample screenshot of our scouting sheets. Lines in orange indicate our opponents while lines highlighted in green represent our alliance teams. The lines with no information or missing information are the ones included in our scouting sheets at worlds when we physically find teams and talk to them. We have included "states record," "Auton points at states," "rank at states," how they qualify for worlds, and "other."

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Joystick Control 4/20/18

We use a dual driving system, so it is helpful to label our joystick control:

Mobile goal out

Mobile goal in


Movement on drive

6U: Rollers move forward

5U: Lift Up

6D: Roller on goliath move backwards

5D: Lift Down

Chain bar up

Chain bar down


Above illustrates our joystick control, showing which buttons control each component of the robot.

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Night Before Departure 4/22/18

To conclude, our robot has a 4 motor speed drive with a chain bar, a 4 motor 7:1 gear lift, a 1 motor 3:1 mobile goal intake, a 2 motor 5:3 gear chain bar, and a 1 motor 1:1 roller stack goliath. On our mobile goal, we can stack up to 11 cones, while on stationary we can stack up to 6 cones.

After practicing last rounds in a 1 minute 45 second interval, we packed up, making sure we have everything for worlds. We see worlds as a rewarding opportunity to see the top tier robots and interact with them. We must make sure to have our robot 100% ready when we go to qualification rounds, as it was a mistake that was careless at the state competition. Our goal for worlds is to make every minute count. We want to not only do well, but show case good sportsmanship and teamwork to keep every member's spirit up. We must be respectful to all teams, alliance or opponent. Overall, we are thankful and joyous to be given the opportunity to worlds.

Competition Checklist:

- ✓ 12 charged batteries
- ✓ Toolbox (screws, nuts, standoffs, axles, etc.)
- ✓ Rubber bands
- ✓ Wire & Gear Boxes
- ✓ Orange cable + Anton switch
- ✓ Safety glasses (3)
- ✓ Joysticks
- ✓ 48 AAA batteries
- ✓ Vex key
- ✓ Computer
- ✓ Robot
- ✓ Replacement wires
- ✓ Friction Padding
- ✓ Zip ties
- ✓ Metal
- ✓ Scouting sheets
- ✓ Business Cards
- ✓ Calculator

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