ENGINEERING NOTEBOOK

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Black Tie Robotics

2616B

Engineering Notebook

2012-2013

Continued from page

Primary Idea

After seeing the Sack Attack reveal, we decided that we wanted to build a robot that could hold a large number of sacks and score on every goal. Because of the layout of the field with the wide troughs, we decided we wanted the ability to strafe so that while scoring, we could spread the pieces along the trough making them tougher to descore. Therefore, we decided to use mecanum wheels because they provide an easier way to strafe.

For the lift, we wanted to avoid a 4 or 6 bar linkage since the torque needed to lift increases as the lift goes up. Instead, we wanted to build a linear lift since the torque needed to lift stays consistent throughout allowing us to lift more sacks. Therefore, we decided to build a scissor lift since they can easily reach the 30" goals while still starting out below 15" so that we could go below the trough. Therefore, we started out by planning a scissor lift for high torque.

The drawing on page 3 shows the plan, with a 6 tooth sprocket chained to a 30 tooth sprocket. On the same axle as the 30-tooth is a 12 tooth high strength gear powering ~~the~~ a ~~vert~~ horizontal linear slide rack gear system. The end of the rack gear slide would have one side of the scissor lift attached, so as the slide moves forward, the lift goes up.

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

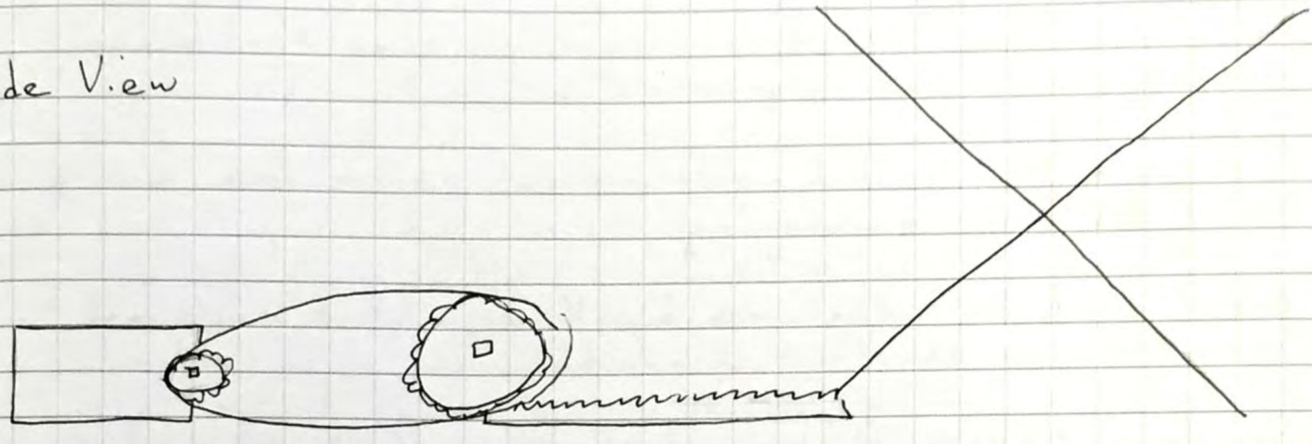
Continued to page 2

DATE 4/19/12

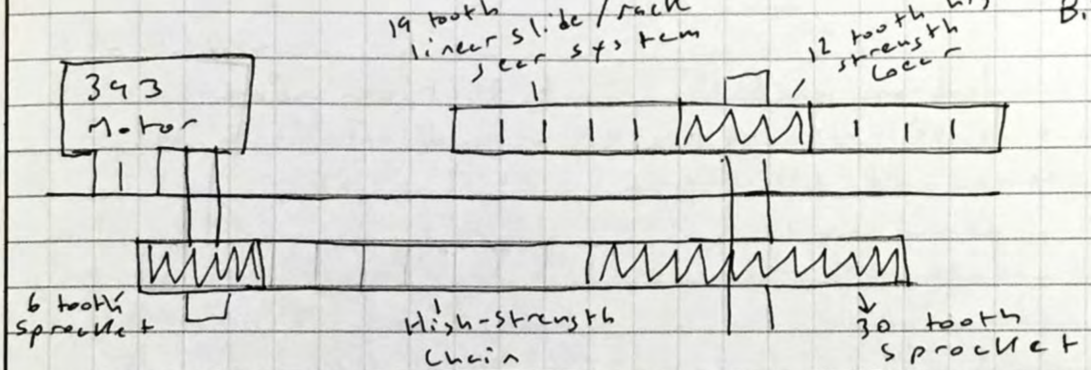
Continued from page 2

Scissor Lift Diagram

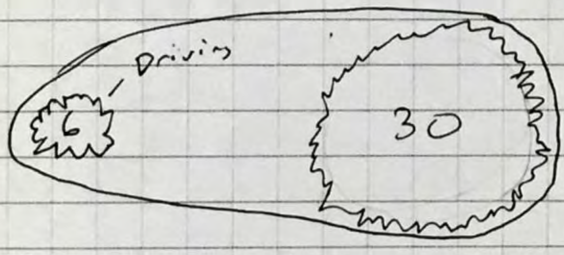
Side View

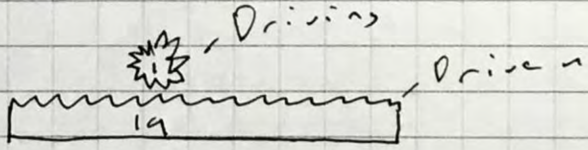


Bird's eye view



Torque Calculations





1:5 for torque

12:19 for torque

1:5 × 12:19 = $\boxed{\text{1:7.917 for torque}}$

Continued to page

SIGNATURE

DATE 4/19/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Game Strategies

After looking through the forum, we found that many teams were considering several designs:

- Wall bots: Robots that would prevent others from moving around the field or scoring
- Hoarders: Robots that would pick up a lot of sacks and score them in the last second.
- Stackers: Robots that would stack sacks high up in the trough.

Therefore, we decided we wanted a robot that can score on every goal, but also be able to de-score and act defensively to counter hoarders and stackers.

Continued from page

Intake

Noting that the sacks shift quite a bit, we decided to intake sacks from the top with an intake that can shift up or down yet remain firmly pressing down on the sacks with elastic support to accomodate any orientation the sacks could be in. Therefore, we decided to use intake rollers because the rubber can move with the sacks to bring them in. We also decided to put in a plexiglass ramp to aid in out-taking the sacks and to also give the ~~sacks~~ rollers an angle to grip on. We also wanted a small omni-wheel on the bottom so that the intake could go very low with minimal hindrance in the drivetrain's capabilities.

Additionally, we designed a defensive mechanism dubbed "wing-rakes" for the intake. Like how the prongs of a rake catch leaves and pull them in, we want to have two bars at the back of the intake with rake like protrusions that would allow us to descore sacks. It could descore many sacks by first driving the robot backwards and lowering the rake wings into the opposite end of the trough, and then driving forward while driving in and out of the trough effectively descoring it. The "wing" part of the name comes from the fact that the wings would extend outwards from the intake like shown on the next page so that we could descore a large portion of the trough at once. Finally, we discussed how we would attach the intake to the scissor lift.

Continued to page 6

SIGNATURE [signature] DATE 4/27/12

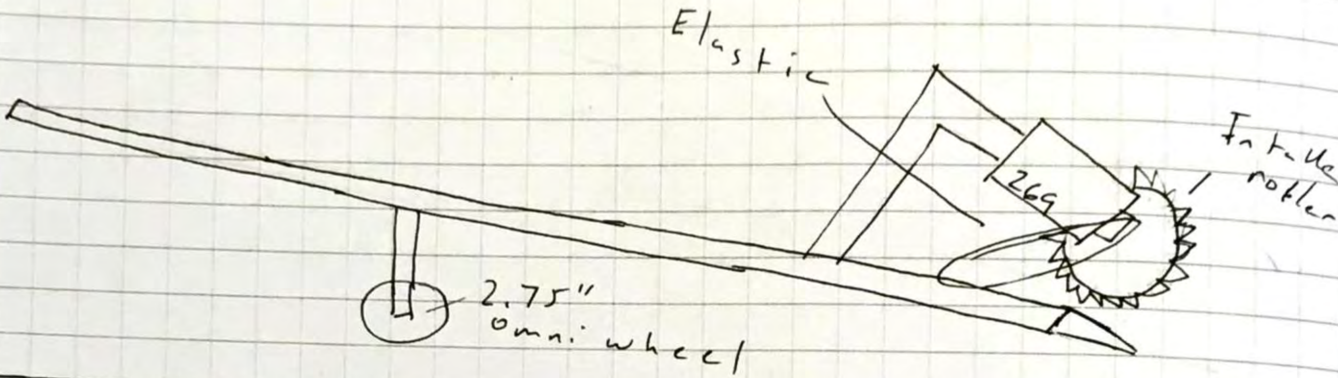
DISCLOSED TO AND UNDERSTOOD BY DATE

PROPRIETARY INFORMATION

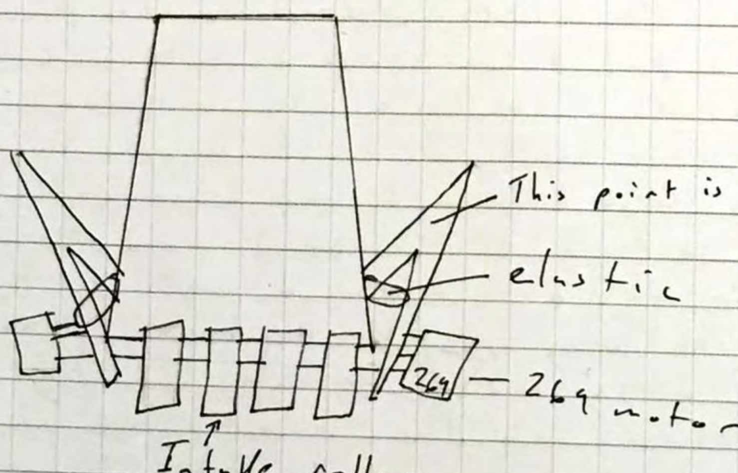
Continued from page 5

Intake Diagram

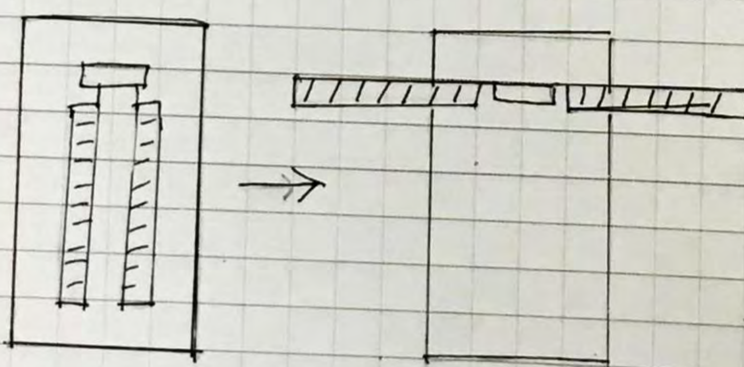
Side view



Front View



Underneath



"Rake-Wings" attached on backside to not interfere with scissor, and starts folded up to be within 18". However, once extended, can be used to cover trough or to descore large parts of trough.

SIGNATURE

Continued to page 7

DATE 4/27/12

DISCLOSED TO AND UNDERSTOOD BY

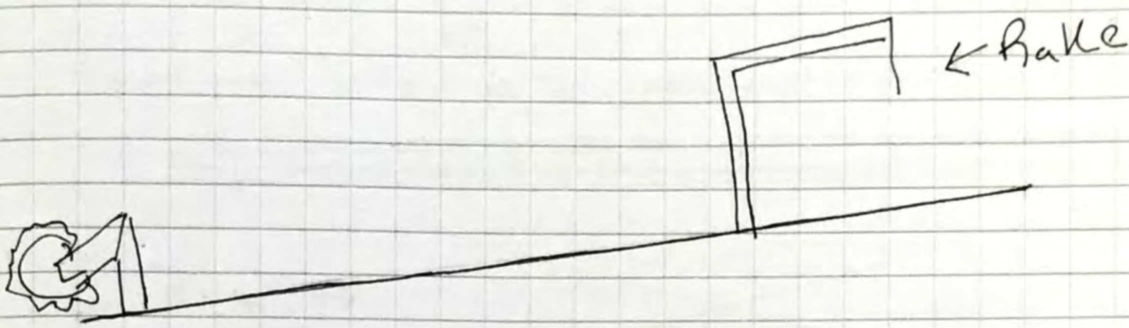
DATE

PROPRIETARY INFORMATION

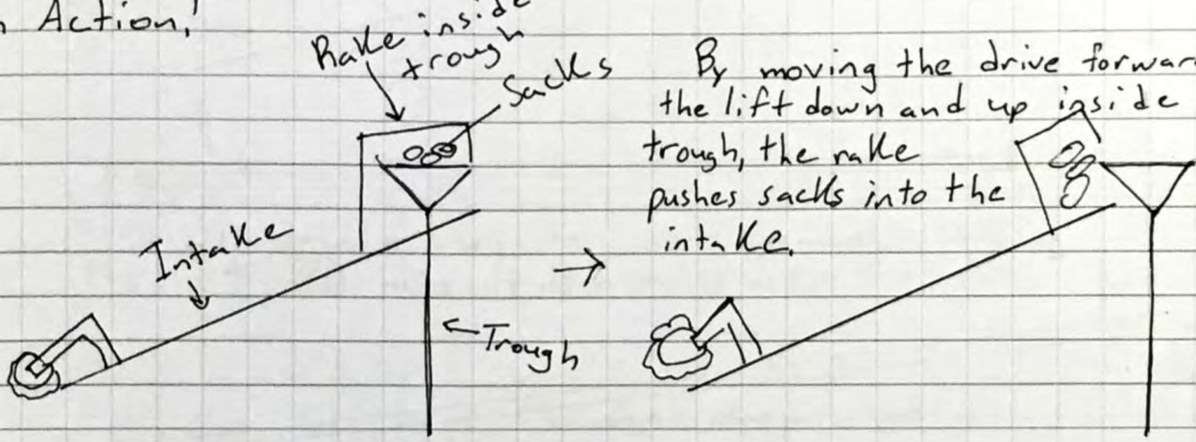
Continued from page 6

"Wing-Rake" Variations

Rake over intake - Descores trough into the intake



In Action!



By moving the drive forward, and the lift down and up inside the trough, the rake pushes sacks into the intake.

Pros!
- Gives robot two ways to intake sacks
- Allows for large point swings
- Efficient way to score if done correctly
- Makes robot more defensive

Cons:
- Increases weight of intake
- Requires lots of practice and coordination between drivers to work
- Can waste a lot of time attempting to descore if drivers not in sync.

Continued to page 8

SIGNATURE

DATE 4/27/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

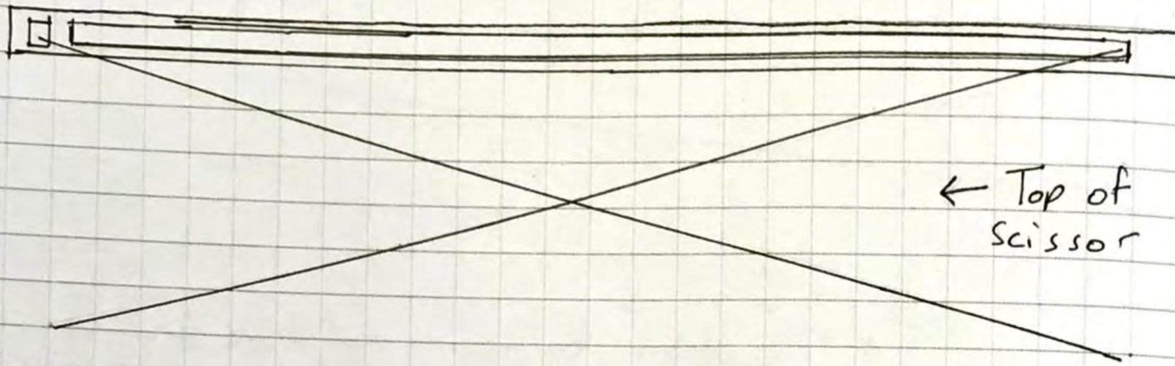
PROPRIETARY INFORMATION

Continued from page 7

Intake/Scissor Attachment

A plan for attaching the intake to the scissor lift at an appropriate angle

① Slotted angle to attach sides but still allow movement



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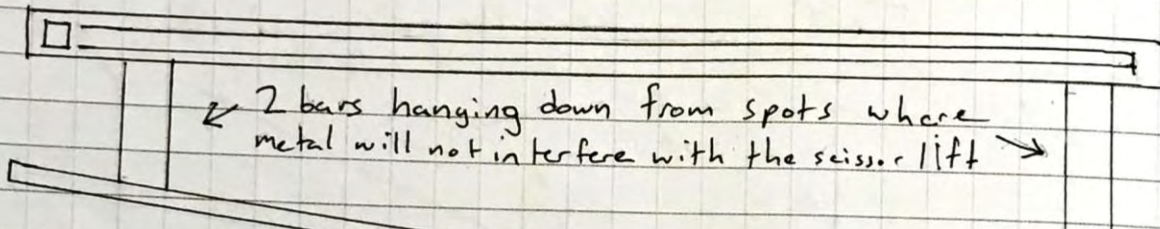
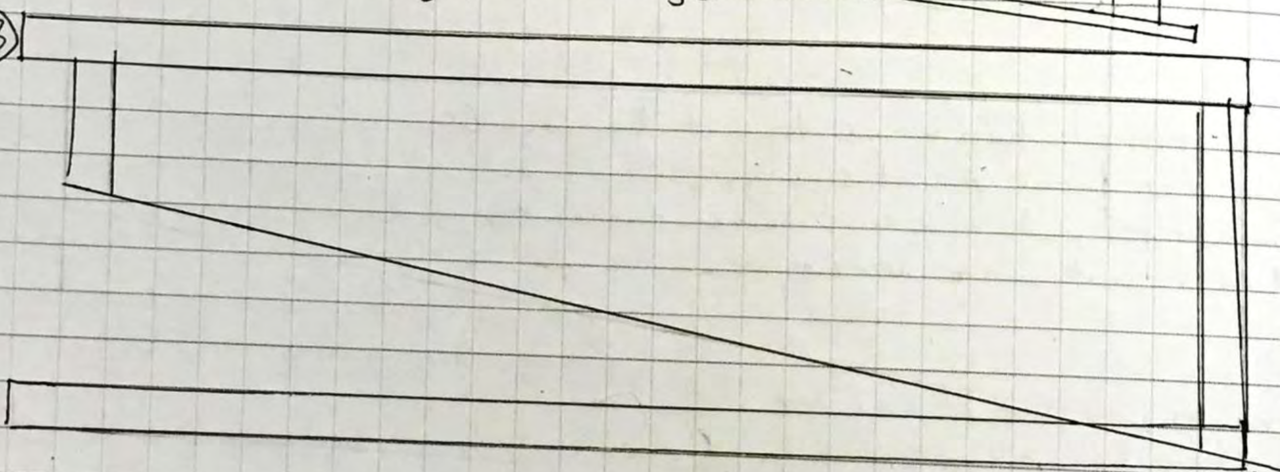


Mount ramp on bars, difference between lengths create angle

③



This configuration will allow the ramp to be as close to the ground as possible when the scissor is lowered.

SIGNATURE

Continued to page

DATE 4/27/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Brainstorming Improvements

Today, we looked at the plans already made for the scissor lift and intake, and discussed ways to improve them. We first discussed the advantages and disadvantages of a scissor lift and made the following chart.

Scissor Lift	
Pro's	Cons
- Starts out low	- Lots of moving parts (means lots of Friction, more complicated)
- Can easily reach the 30" goal	- Gets more unstable as lift raises
- Linear motion (torque stays constant)	

because of the stability issues, we decided to abandon the scissor lift for a more stable lift with linear slides. We looked at the two stage elevator lift used by team 1103 in the Round-Up season and decided to build one since it has all the pro's of a scissor lift without the stability issues.

We also wanted to improve the intake, so we decided to use Wheel legs instead of rubber rollers to intake. Because of their larger size, they will spin faster and grip sacks better than the intake rollers. We also realized that as we intaked more sacks, they would bunch up at the front making the intake motors work harder to move and making it more difficult to intake. Therefore, we decided to make a conveyor-bet ramp instead of a plexiglass ramp with high traction foam attached to the treads to push sacks out of the wheel-leg's way allowing us to intake more.

Continued to page 10

SIGNATURE

DATE 5/2/12

DISCLOSED TO AND UNDERSTOOD BY

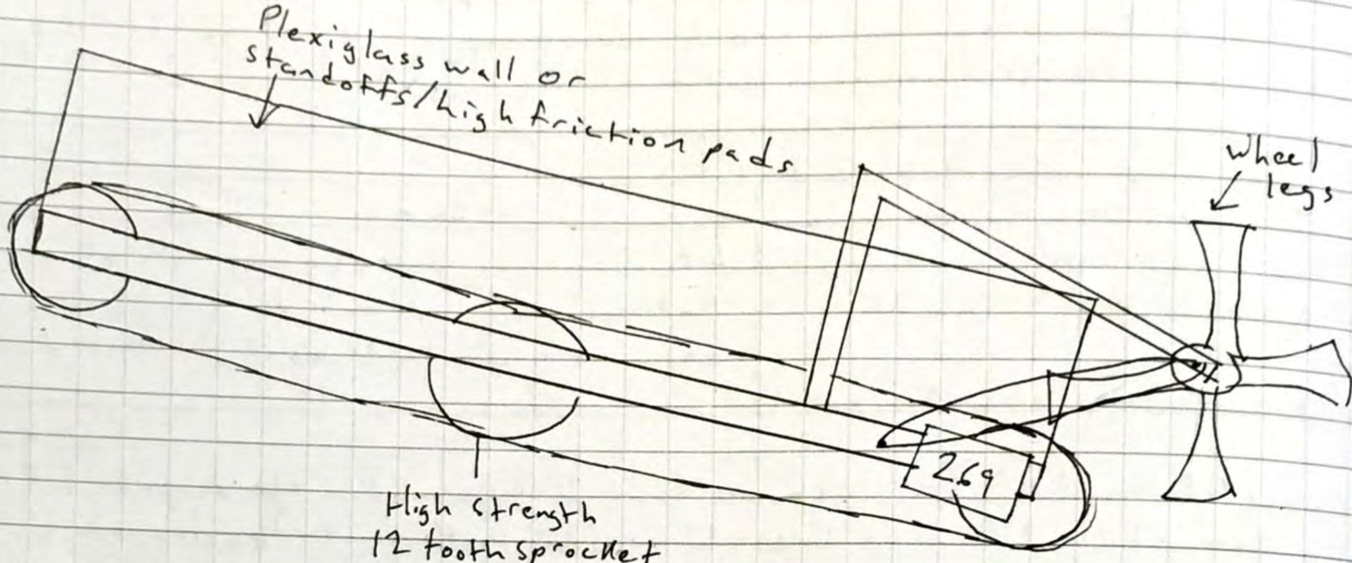
DATE

PROPRIETARY INFORMATION

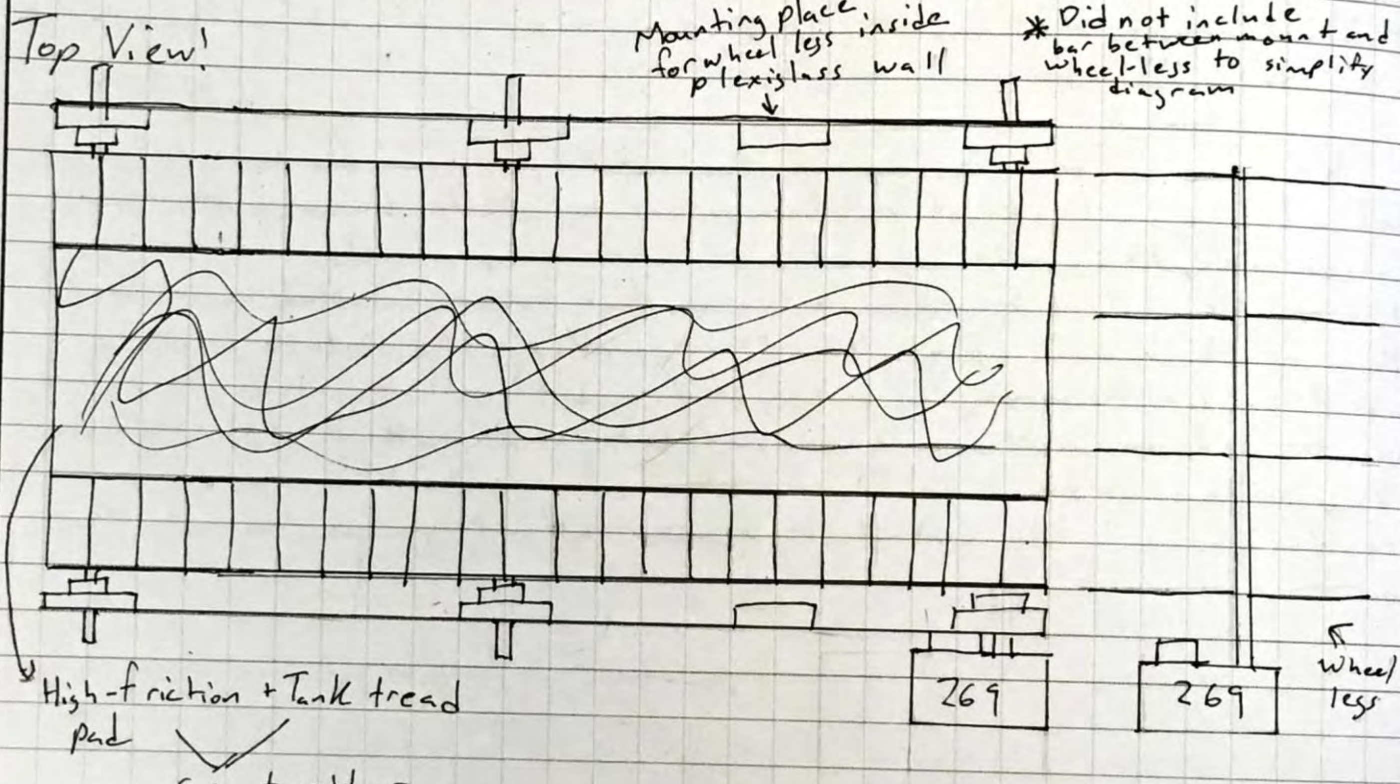
Continued from page 9

New Intake

Side View!



Top View!



SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued to page

DATE 5/2/12

PROPRIETARY INFORMATION

Continued from page

Organization and Brainstorming

Today we mostly cleaned and reorganized the robotics room because it was quite messy and disorganized from the frenzy before Worlds last year. We also discussed ideas for the robot.

We noticed that 677's Gateway robot had a modularized drivetrain, meaning that their drive motors could be easily removed from the rest of the robot. This makes it easier to tighten motor screws. Last year, we nearly had to disassemble our lift gearing every time we wanted to change the motor screws on the lift motors so we decided to have that on our robot. We would do it by attaching the motors to a plate which screws to the robot through standoffs.

We also discussed a possible addition to the rake wings. Instead of the rakes simply dropping sacks to the floor, we would have the rakes over the ramp so that it would drop sacks into the intake. We would also have triangular extensions on the sides to push the sacks inside the trough into a compact group for a quicker descore. A diagram is included in the following page.

Continued to page 12

SIGNATURE

DATE 5/7/12

DISCLOSED TO AND UNDERSTOOD BY

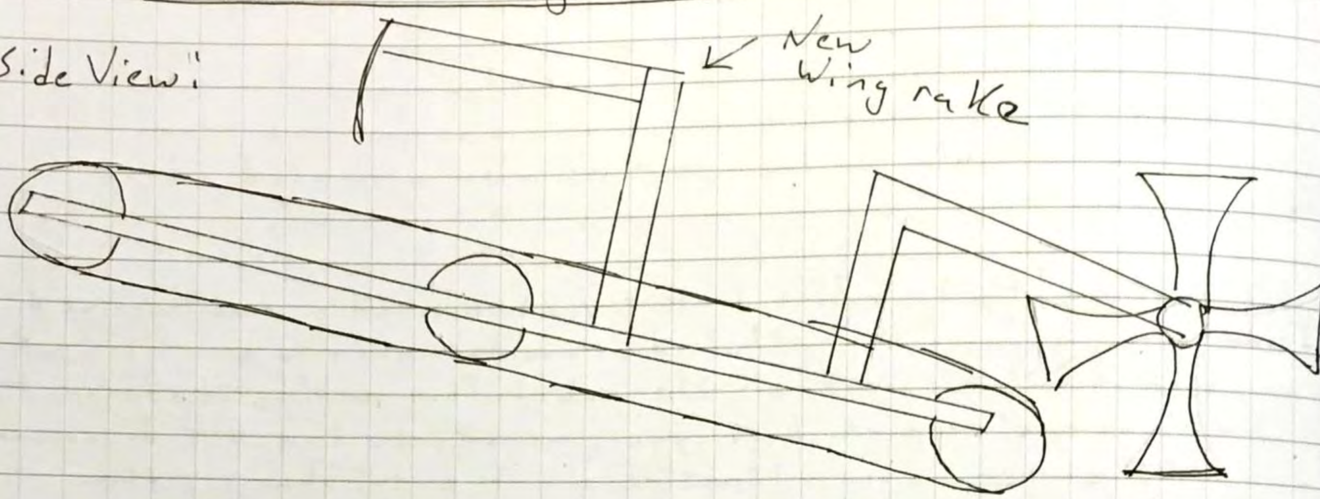
DATE

PROPRIETARY INFORMATION

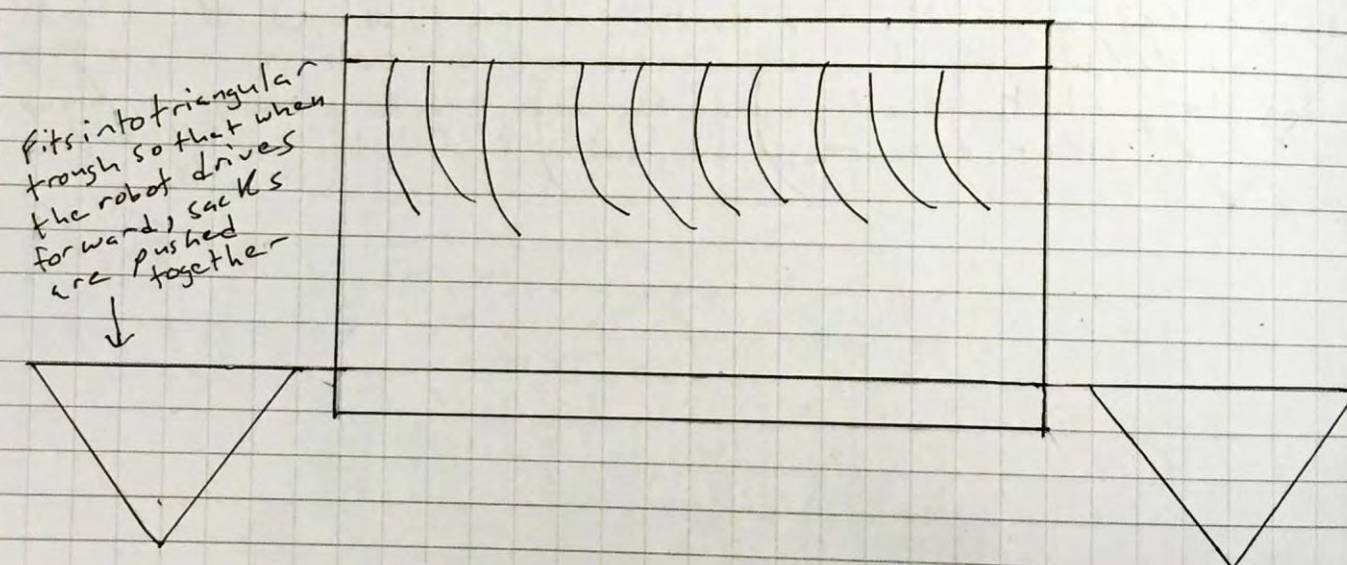
Continued from page 11

Rake Wings V2

Side View:



Back View:



SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued to page

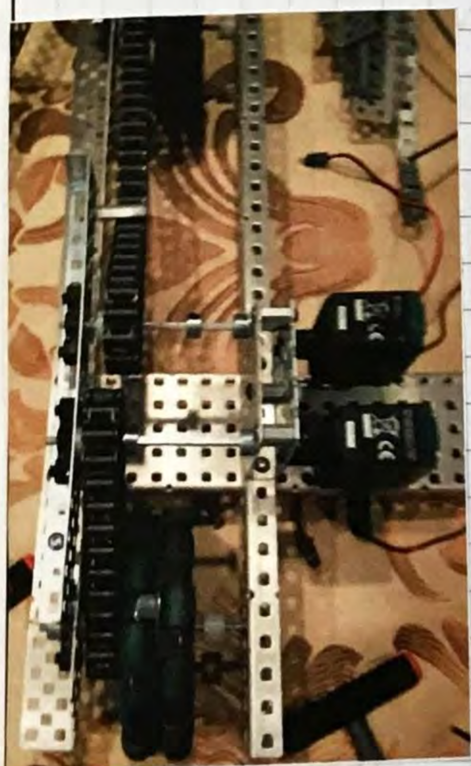
DATE 5/7/12

PROPRIETARY INFORMATION

Continued from page

Drive Build + Lift Brainstorm

Today, we started building a u-shaped modularized drive, using a large, 5 hole wide C-shaped bar as the main support site, with two aluminum L-bars and C-channels housing the wheels. Since we want a mechanum wheel design where every wheel is powered separately, we put a central spot for the two motors with high strength sprocket and chains leading to the wheels. We chose this configuration because it allows us to easily take off the plate with the motors and tighten the screws. A picture of the drive is shown below.



We also considered a new idea that would allow us to reach the 30" goal with a simple linear slide lift. The intake would still have wheel legs, but it would have compartments for sacks which would be filled by a ramp. The compartments would be made of two conveyor belts next to each other with metal in between and a plexiglass wall to keep sacks from falling out. Once a compartment filled, the conveyor belts would run to bring a new compartment to fill. When full, the conveyor belt system, separate from the wheel legs would rise through the linear slides, and the sacks would fall out when the two linear slides ran forward. There is a diagram of the design on the next page.

Continued to page 14

SIGNATURE

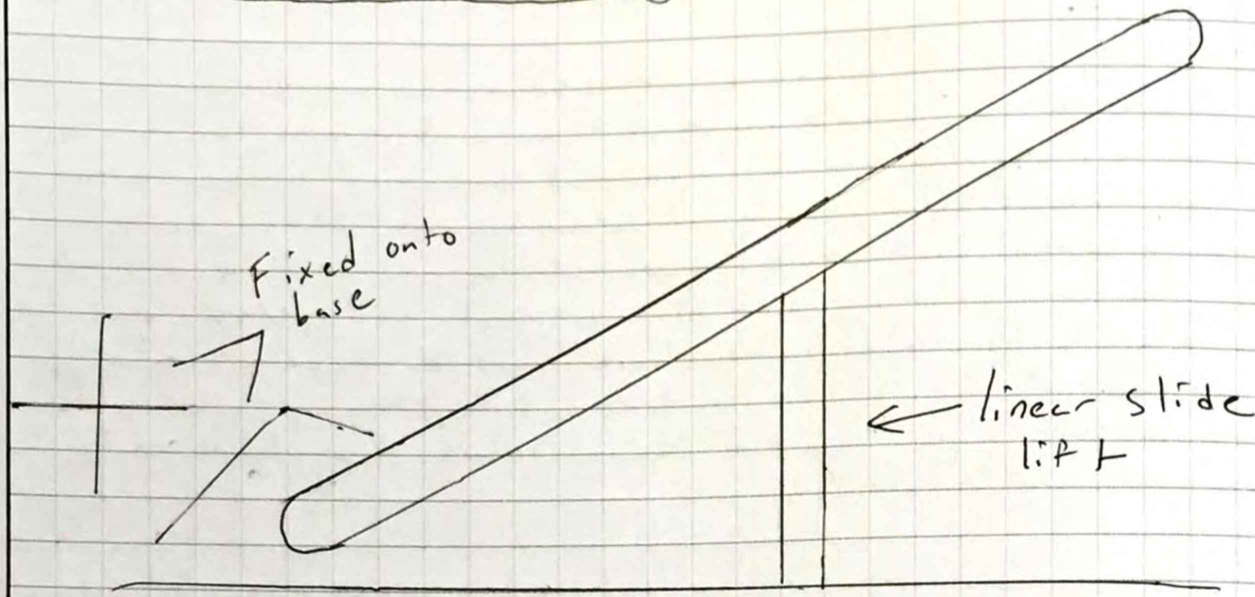
DATE 5/17/12

DISCLOSED TO AND UNDERSTOOD BY

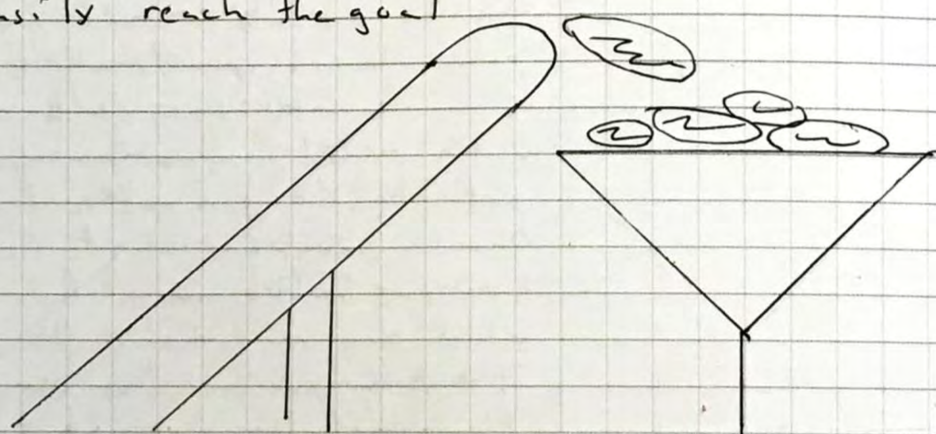
DATE

Continued from page 14

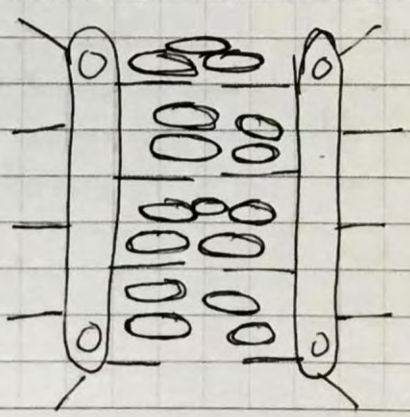
Concept Diagram



Simple linear slide lift can easily reach the goal



Frontal View!



Intaked sacks fall into "floor" of elevator made by conveyor belts with metal attached. Can have multiple floors, once full, the elevator raises and then going up causes the sacks to fall into the trough

Continued to page

Continued from page

Building Drive + Lift Concept

Today, we continued to work on the drivetrain, attempting to finish the other side. We also tried to design an alternate intake/lift with a linear slide lift and a conveyor similar to the design on page 14, but this one would have a rotating conveyor. The conveyor would be mounted to one spot to allow it to rotate, and we would control the rotation by attaching a rope to the back of it, tied to the base. That way, as the lift raised, the rope would tighten, and that tension would force the lift to go vertical allowing us to score on the high goal and troughs.

Continued to page 16

SIGNATURE

DATE 5/27/12

DISCLOSED TO AND UNDERSTOOD BY

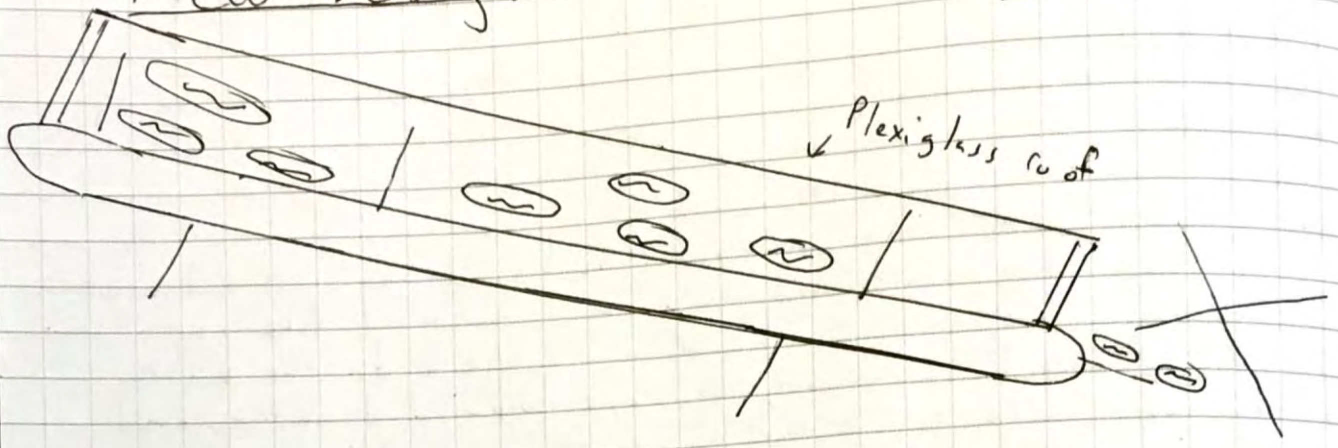
DATE

PROPRIETARY INFORMATION

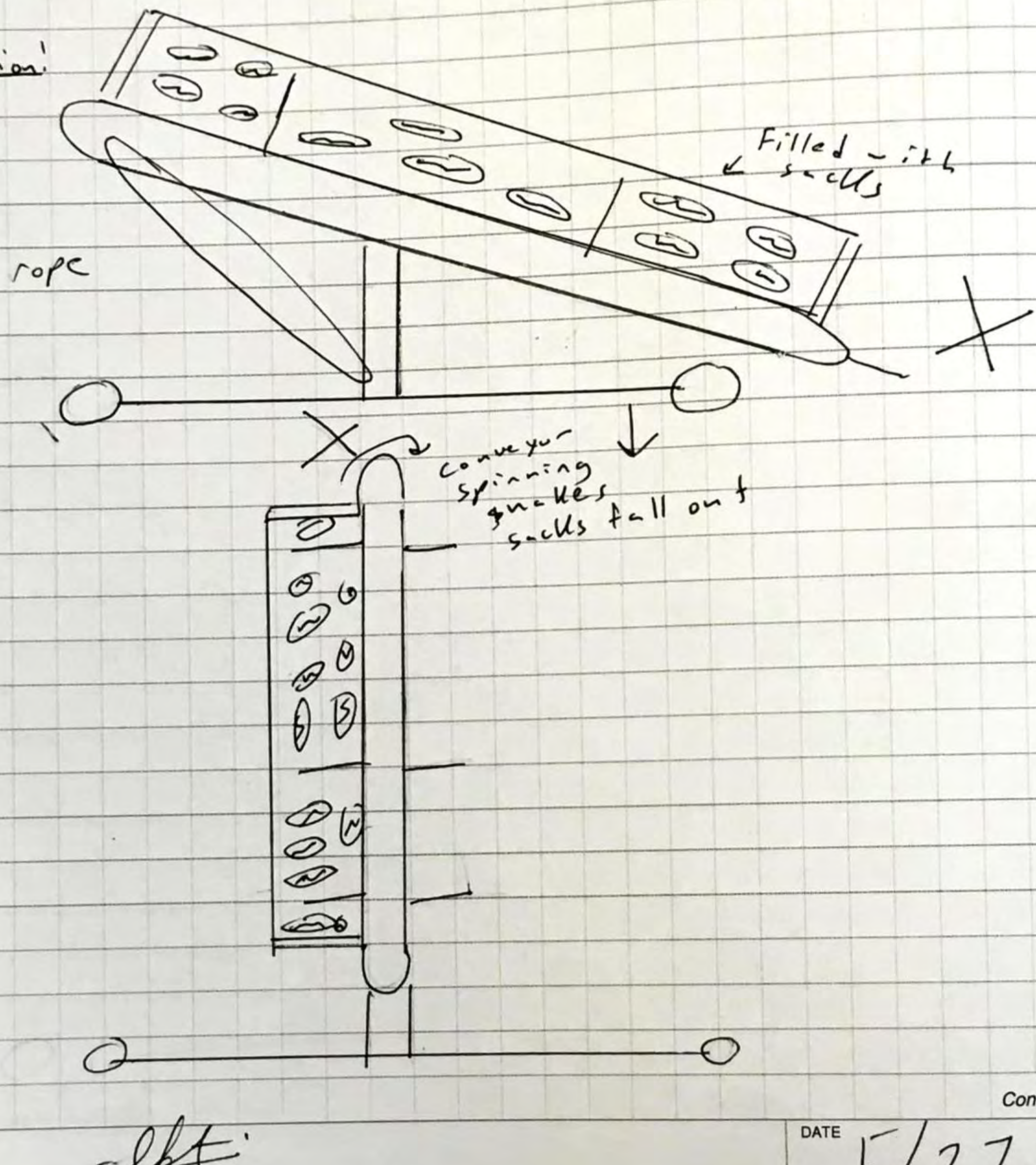
Continued from page 15

New Design Concept

Side:



In Action:



Continued to page

SIGNATURE [signature]

DATE 5/27/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Lift Idea + Dealing with Sacks

This meeting, we disregarded the last idea since it was overly complicated, using rope as the basis of reaching the goals is too risky, and it would be difficult for the sacks to come up when the elevator is vertical because of gravity. Therefore, we started to research past linear lifts. During our search, we found team 1103's robot from Round-Up which used a two-stage elevator lift using continuously running chain. Inspired by this, we began searching Vexforum for more information on the lift. During our search, we found an animation by Jpearman showing how the elevator lift works. After watching, we decided to build a prototype of the lift over the next week.

Afterwards, we began discussing the trouble with sacks getting stuck on drivetrains. We decided that we would add triangular skirts to the front of our drivetrain. The triangles would end where the ramp of the intake, shown on page 10, begins. That way, sacks will be pushed into our intake instead of going into our wheels. To stop sacks from entering our drivetrain from any other points, we will either put stand-offs or plexiglass very close to the ground near the sacks so that sacks would get pushed away instead of entering the drivetrain. Diagrams of the triangular drivetrain are detailed on the next page.

Continued to page 18

SIGNATURE

DATE 6/2/12

DISCLOSED TO AND UNDERSTOOD BY

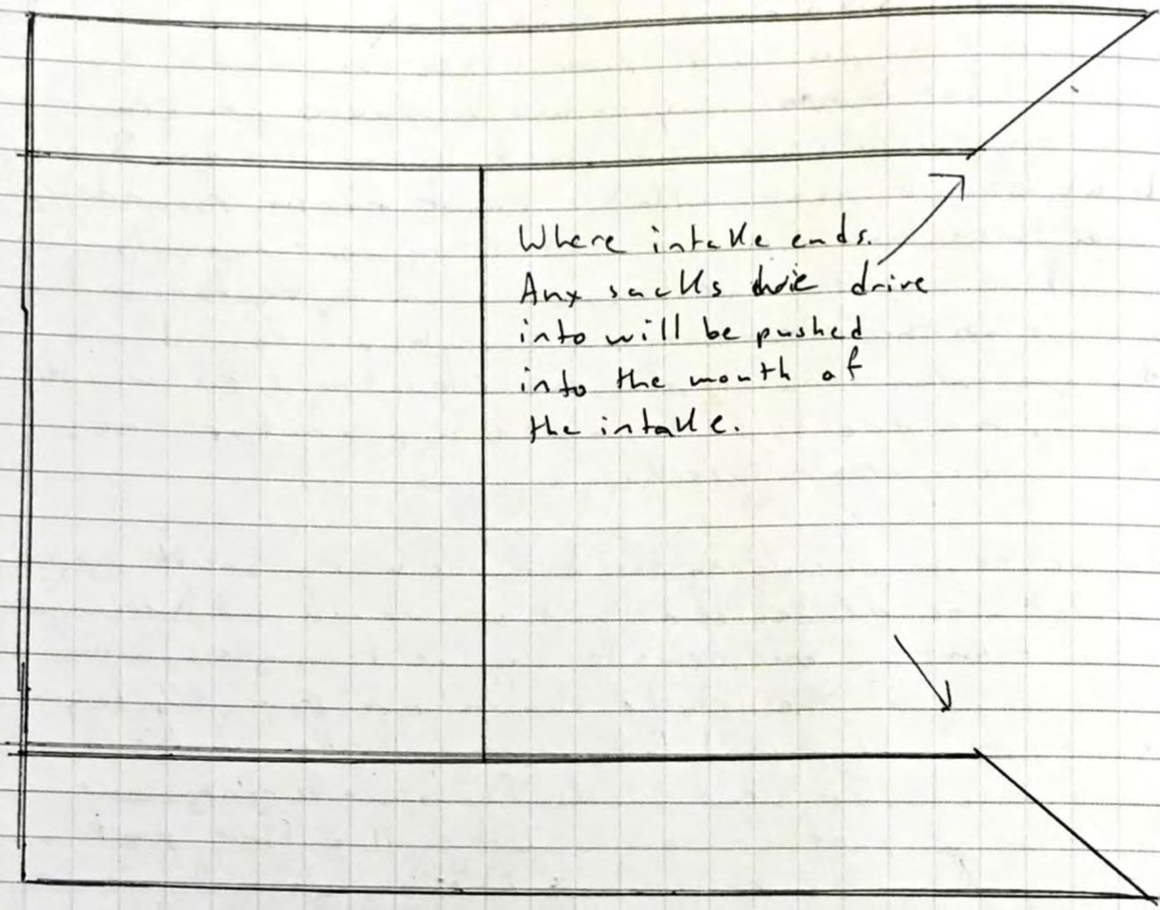
DATE

PROPRIETARY INFORMATION

Continued from page 17

New Modularized Drivetrain:

Top View:



Continued to page

SIGNATURE

DATE 6/2/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Built Lift Prototype

Today, we built an elevator lift based off of Jpearman's animation on a cut 5×5×35 piece c-channel, pictured

on the left. From the prototype, we deduced that the left most bar must be mounted to the base, and the bottom two sprockets must also somehow be attached to the base. We made the sprockets go through the c-channel to make the lift function. We also concluded that how high the lift can go is dictated by the distance between the sprocket in the middle, and upper left. In the photograph, the middle bar cannot go any higher because the right sprocket is hitting the left one, Therefore, if we lowered the sprocket on the middle c-channel, the bar would be able to travel more distance up before reaching the upper left sprocket, therefore increasing the maximum height.

Continued to page

SIGNATURE

DATE 6/17/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Mounting the Lift

Today, we tried to mount the lift onto the robot by taking the lift prototype we had, and placing it around the middle of the robot. However, the drive motors were in the way, so we decided to try a new method of modularizing the robot by attaching an L-bar

to the central c-channel as shown on the picture to the left. The motors, mounted on the L-bar could easily be removed by unscrewing the L-bar from the c-channel. We attached a high goal descorer consisting of a piece of metal at the end of a bar that would allow us to descore the opponent's high goal from our side. We would descore by sliding the metal in front of the plexiglass of the high goal, and then driving forward, therefore knocking all of the sacks out of the high goal.

We also mounted the lift with lots of stand-offs as shown to the left, and a triangle as shown above, to grant stability. We moved the outer lift c-channel down so that it could also be mounted to the robot. This ensures that the lift cannot sway outwards or inwards, while the triangle ensures it cannot move forwards or backwards. Finally, we began work on the conveyor belt.

SIGNATURE

Continued to page

DATE 6/22/12

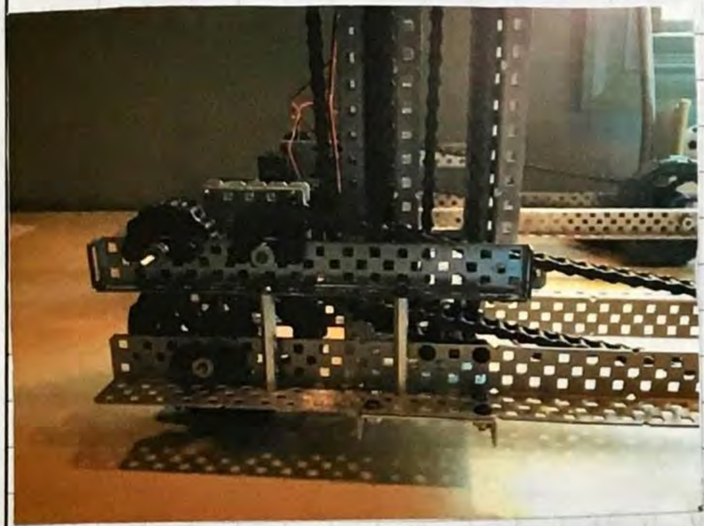
DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Improving Mount of Lift

After a long hiatus, we looked at the mount again, and realized that the mounting was too unstable because the lift and drive were built separately and shoddily attached. We rebuilt it, this time having the lift conform to the drivetrain making a more stable fit. We mounted the base c-channel of the lift to the right angle between one side of the drive and the central, 5-hole wide c-channel to give the bar lots of points of contact. We mounted the lift with the bare c-channels facing inwards so that the intake could be directly mounted to the lift.



We also changed the modularization back to what we had before, but we put it behind the lift. We added a rail on stand-offs to give the axles support, and with both motors being in the same spot, we can easily tighten both just by removing the plate the motors are attached to.

Finally, we thought about how we would gear each side of the lift using four motors. While brainstorming several different positions, we quickly realized that having any sort of sprocket near the continuous chain of the lift would only limit our height because the additional gear would cause the closest floor to stop sooner.

Continued to page

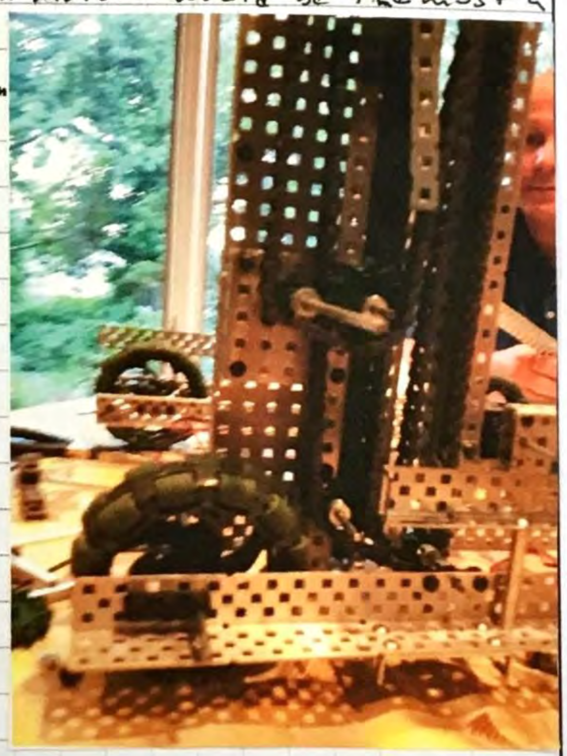
SIGNATURE [signature] DATE 7/15/12

DISCLOSED TO AND UNDERSTOOD BY DATE

Gearing the Lift; Motor Arrangement

After concluding that the motors cannot go on the lift itself last meeting, this time we brainstormed ways to power the lift away from the stages of the elevator themselves. Looking at the elevator, we realized that the top left sprocket drives the entire lift. Therefore,

we put a rack bracket around that sprocket as shown to the left so that we could attach a bigger gear that would drive the entire lift. We also wanted to modularize the lift, and thought it would be cool to modularize the two together and have them all on the lift. We wanted to add 6 tooth sprockets to the motors, one 269, and one 393, all driving a 30 tooth sprocket to make a 1:5 ratio. Note that the sprockets aren't the right size in the picture to the left and below because we don't currently have the right sized sprockets. We also chose not to use all 393 motors because Mr. Jones from Montclair estimated that 6 high strength motors would be the most a cortex could take without tripping breakers. From past experience, we found that a minimum of four 393's are needed for a good drive train so two 393's were used for the lift.



After adding the motors to the lift by attaching them to a 5-hole wide c-channel as shown to the right, we realized that the motors were very high which would force the intake to be very steep to not interfere with motors. Since a steep ramp would cause gravity to push sacks onto the wheel-legs, limiting the amount we could intake, we decided to find a better way of mounting it next meeting.

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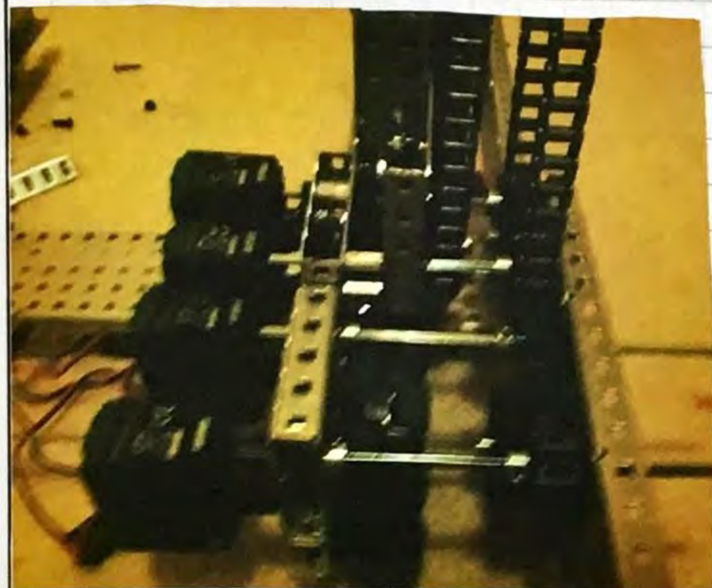
Continued from page

Solving Motor Placement Problems

Because we determined the motors too high up for the intake during the last meeting, this week we decided to revert the drivetrain back to the modularized modules



that we had before. However, as we re-did the drivetrain, we realized that we could also modularize the lift, since it only uses two sprockets which power the far-off large sprocket with chain. Therefore, we put the lift motors behind the lift also, giving us four modularized motors in a row as shown in the picture to the left. This way, eight of our ten motors are easily accesible simply by removing a few screws. We also replaced the rail that was supporting the axles on the other side with a 5 hole wide c-channel because there are much more axles now needing support. Also, the L-bar / stand-off support wasn't very stable since standoffs can sway to the left or right. Also, we couldn't get the holes to line up exactly with the bar in place, so we replaced it with an aluminum c-channel, which makes the two sides even, is more stable since the 5 hole wide c-channel is directly screwed to it and gives us more room in the middle since the c-channel is thinner than the L-bar.

However, after making all of the above changes, we tested everything to check for problems and found an issue with the drivetrain. Because the sprockets driving the front wheel is so far away from it, the chain powering it must be very long and has to go through all the chain, sprockets and metal of the base and lift. This causes the chain to rub on metal, causing unwanted friction, an issue that we will have to resolve next meeting.

Continued to page

SIGNATURE

DATE 8/10/12

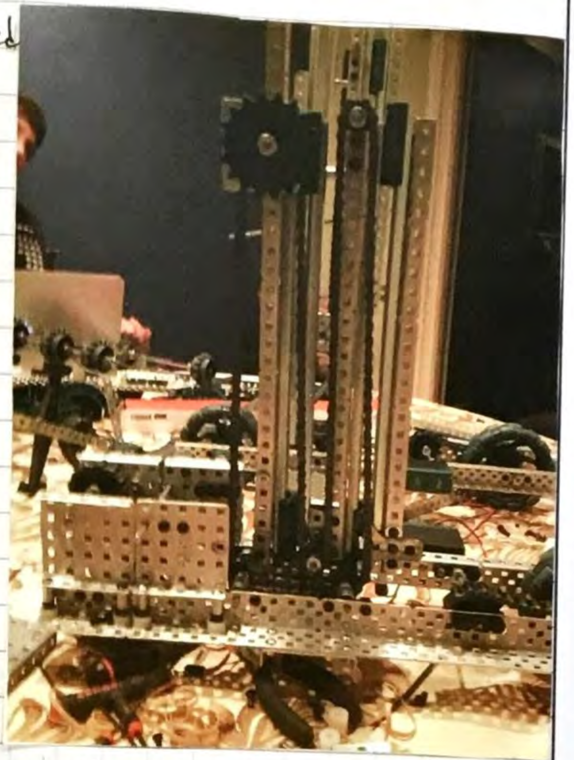
DISCLOSED TO AND UNDERSTOOD BY

DATE

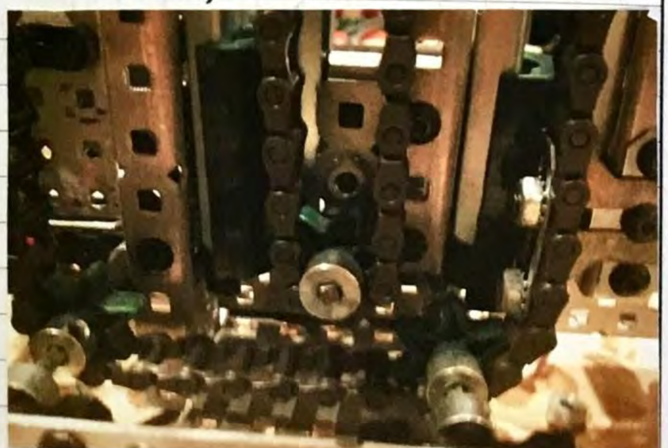
PROPRIETARY INFORMATION

New Drive Motoring and Linear Slides

Today, we solved the problem encountered last meeting concerning the placement of the drive motors. We determined that there was no way we could power the front wheel from the back because of all the things in the way of the chain; so we instead moved the motors of the front two wheels to the front as shown in the picture to the right.



We also received new linear slides so we began replacing the old style linear slides with the new ones we received. Unfortunately, we only got enough 12 inch linear slides ~~[illegible]~~ to complete one side of the lift, so we began ~~bu~~ building the opposite side of the lift with 17.5 inch linear slides and plan to either cut them or purchase more 12 inch long linear slide before the 1st competition. While replacing the old with the new, we had trouble with the delrins as it seemed like there were not enough inner delrins to complete the lift. However, we were using inner delrins in the same place as the outer, which we realized is necessary after inspecting the lift. Once we screwed the outer delrins into the c-channels using spacers instead of delrins, we were able to complete one side of the lift as shown to the right.



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DATE 8/12/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Gearing And Chaining the Intake

Today, we started to build the intake with a conveyor belt and a roller made of wheel-legs chained together so that they could share the motor power. We tried to chain them together at first, but we discovered that the roller and belt spun in opposite directions. But remembering idling gears and how they changed the direction gears spin, so we used lots of axles to attach gears that made the intake conveyor spin the same way as the wheel legs. However, this would require the chain connecting the legs and the conveyor to be on a different axle than the gears which would require lots of space inside of the intake. Instead, we attached two 1x25's together like on scissorlifts and put sprockets inside. However, the tension of the chain would get loose whenever the roller went up. After experimenting, we discovered that the chain stays constant when the sprockets are on the same rotation as the rest of the lift.

Continued to page

SIGNATURE

DATE 9/20/17

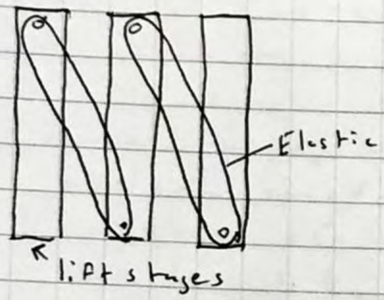
DISCLOSED TO AND UNDERSTOOD BY

DATE

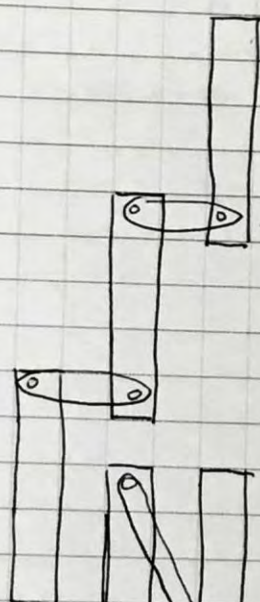
Continued from page

Testing the Lift; Fixing Problems

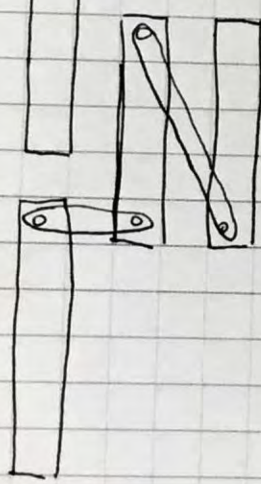
Today, we completed both sides of the lift and tested out how they worked. The furthest level from the base would get loose because the middle level would not go down. Therefore, we decided to add elastic to the lift to assist it in carrying sacks and to force the middle level of the elevator to go down. The rubber bands would look as follows:



- The tension of the elastic is going upwards, so it would assist in lifting. This picture shows the lift at starting position.



- When the towers are up as shown, the rubber bands will be loose.



- However, when the furthermost tower begins to go down, the elastic would tighten, bringing the middle bar down as well.

SIGNATURE

Continued to page

DATE 8/21/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Intake Ideas

Now that we have a better understanding of the game, it is apparent that storing over 20 sacks will be difficult and require a lot of space. Therefore, we designed an intake where the conveyor belt would drop sacks into a bucket that would raise thanks to rope tension on page 28's diagram. However, another member came later and had the idea of having a door at the back instead so that sacks would simply fall out and the lift wouldn't have to support changing the angle of the basket. Instead, rope would be used to force the door down.

Continued to page 28

SIGNATURE

DATE 8/23/12

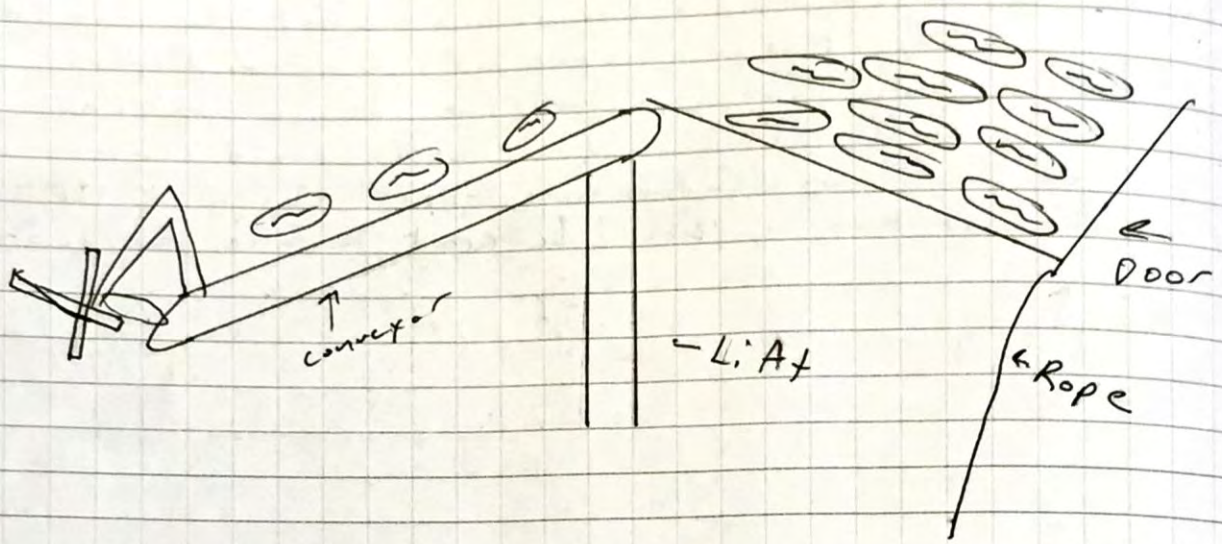
DISCLOSED TO AND UNDERSTOOD BY

DATE

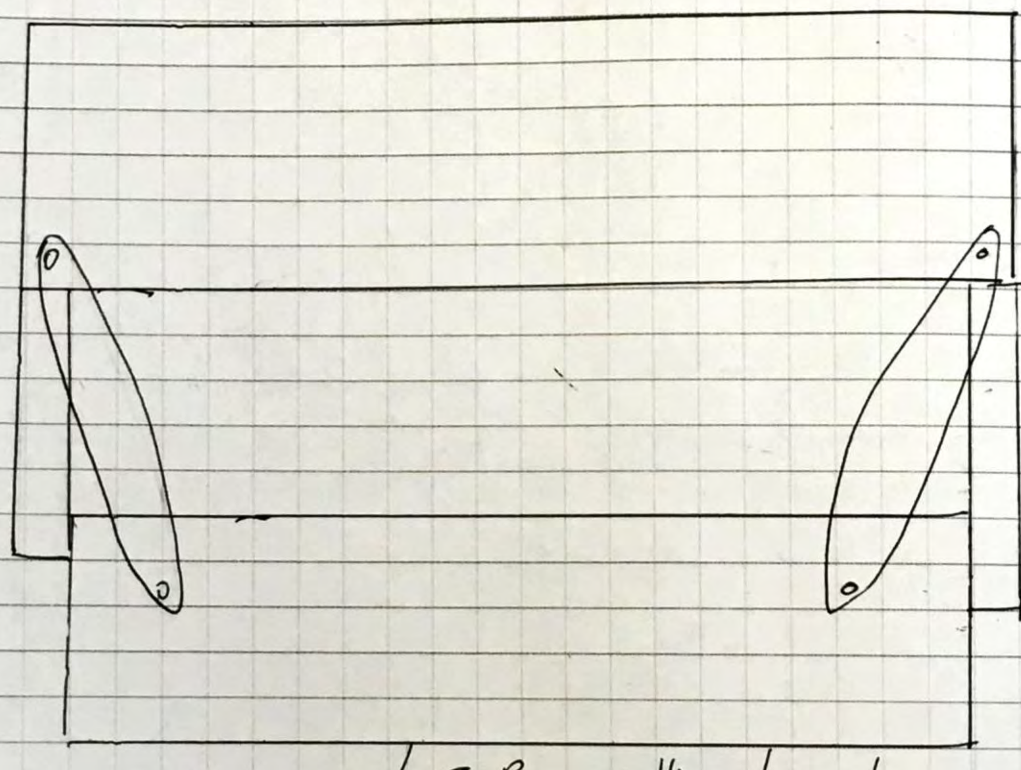
PROPRIETARY INFORMATION

Continued from page 27

Rope Intake



Door!



← Rope pulling door down so that sacks can fall out.

Continued to page

SIGNATURE

DATE 8/23/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Attaching Intake / Teaching

With the school year underway, our team has recently been busy teaching new students about robotics and helping them design. Therefore, we have not been able to meet much.

However, I was able to the robot home and create a prototype of the conveyor belt with the basket and door. After the conveyor belt ended, I added in a small ramp that went over the motors, and then one at a more drastic angle as shown in the picture to the left. I have no plexi-glass so I used a few plates to keep the ramp together at least. I also started building the door by attaching metal to the back of the ramp (which

would flip down) with space in between so that a door could slide up and down as shown in the picture to the left. Also added elastic to the door (a metal plate) so that the door would close once the intake came down.

Once that was done, I started to try to attach the intake to the lift, but the lift was too far apart for the intake. Therefore, I looked for a way to attach the lift to the intake without using stand-offs because they tend to get loose easily and ~~transfer~~ give support

Continued to page 30

SIGNATURE

DATE 10/2/12

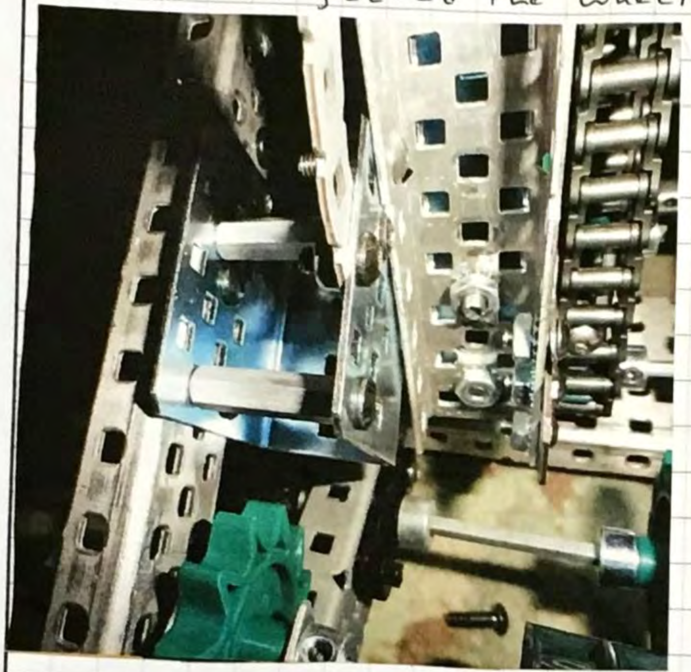
DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page 29

Attaching Intake / Teaching (cont'd)

vertically. I played around with several parts until I found the linear slide brackets, which could screw on to the conveyor belt and provide good support for stand-off's as shown below. I then geared the wheel leg intake 1:1 and the conveyor belt 5:1 for torque. We want the conveyor belt to have a lot of torque so that it could carry as many sacks as possible to the ramps. Finally, we geared the lift 1:5 for torque using 12 and 60 tooth high strength sprockets.



Above: Ramps with sack inside

Below: Front view of Robot.

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued to page

DATE 10/2/12

PROPRIETARY INFORMATION

Continued from page

General Improvements

Today, we got two more linear slide kits so that all of our linear slides would be 12 inches long. We also added elastic to the lift after replacing the linear slides. However, since the middle level of the lift is not attached to the base or intake like the other two, it gets pulled up by the elastic when the robot is all the way down. Therefore, we decided to make a mechanical stop that would prevent the middle tower from going higher than the outer most level. Therefore, we put a cap on top of the upper linear slide so that the inner delrin of the middle slide would not be able to go over the outer delrin. We also mounted the cortex using small stand-offs so that we could run wires underneath it and keep the robot looking clean.

Continued to page

SIGNATURE

DATE 10/4/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Pre-Match Checklist / Scouting

Here is a checklist we made for us to use before each match to make sure the robot works optimally.

- ☐ Connections Wired?
- ☐ Structural Integrity
- ☐ Battery Power (Plugged in?)
- ☐ Tightness
- ☐ Working Condition of Robot
- ☐ Programming working

We also decided to use the scouting manager app on the iphone to scout during competitions.

Continued to page

SIGNATURE

DATE 10/4/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Programming

The User Control portion of the program has three main components. Mapping the controls to the drive, lift, and intake.

DRIVE

```
motor[frontLeft] = vexRT[Ch3] + vexRT[Ch1] + vexRT[Ch4];
motor[backLeft] = vexRT[Ch3] + vexRT[Ch1] - vexRT[Ch4];
motor[frontRight] = vexRT[Ch3] - vexRT[Ch1] - vexRT[Ch4];
motor[backRight] = vexRT[Ch3] - vexRT[Ch1] + vexRT[Ch4];
```

This is the code that powers the mecanum wheels on the robot.

LIFT, INTAKE

- The lift is powered by four motors, each of which is set to a fixed value based on a button press, or the value of a joystick on the second controller.
- The intake consists of the intake roller and conveyor belt, and is set to a fixed power value based on a button press

OTHER

- The control scheme is dynamically switched based on the presence of a second controller.

Ampersand

```
bool secondController = nVEXReceiveState & vrXmit2
```

The nVEXReceiveState bitfield has a bit corresponding to the presence. It can be extracted using a bitwise AND operation. (&)

- Joystick values are always normalized:

```
#define JOYSTICK_THRESHOLD 10
#define normalize(a) (abs(a) <= JOYSTICK_THRESHOLD) ? 0 : a
```

Continued to page

SIGNATURE

Edward Yuska

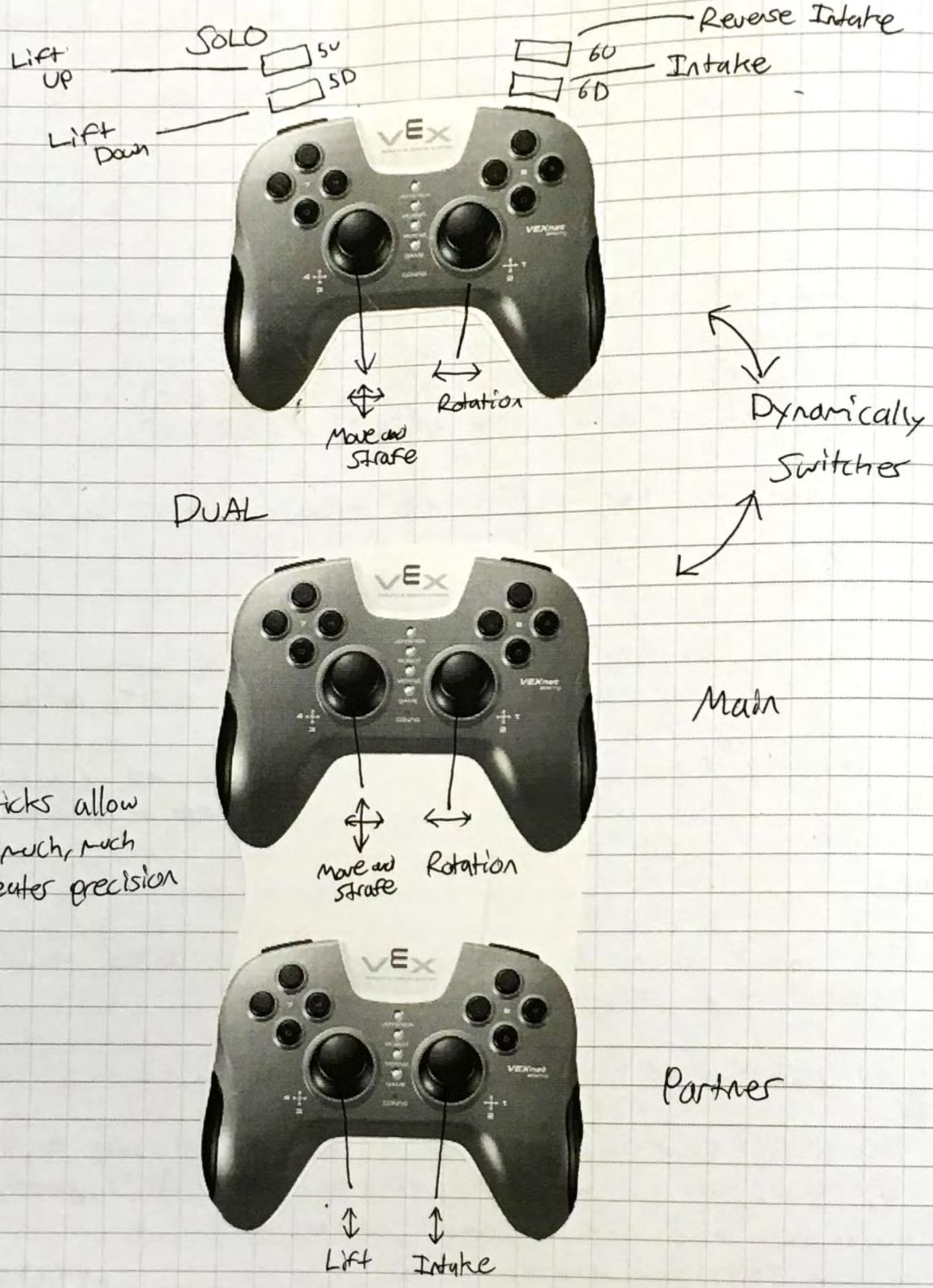
DATE 10/6/2012

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Controller Diagram



Joysticks allow for much, much greater precision

SIGNATURE [signature]

DATE 10/6/2012

Continued to page

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Wiring and Practice

Today, we started to wire up the robot. Because the majority of the motors were in the back, the stand-off mount with the cortex let us run the motor controllers underneath the cortex and bundle them up nicely. We also mounted the power expander in front of the cortex and made battery holders out of 1x25's on both sides of the cortex between the c-channels. This way, the batteries stay secure and out of the way. Finally, we practiced some driving on the field so that our driver could get used to the new style of steering the drive-train.

Continued to page

SIGNATURE

DATE 10/8/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Intake Edits

Got field elements, so we assembled the field. We then checked to see if our robot would fit under the trough, and our lift was just barely too high. We decided to lower all the linear slide delrins by one hole, but we worry that doing so would compromise our maximum height.

We also found several issues with the ~~lift~~ intake also. The bottom of the conveyor belt would touch the forward two drive motors. Also, the axle connecting the wheel-leg to the rest of the intake was too long and would interfere with the mecanum wheels while going up. Also, the design made it so that the chain slackened when the wheel legs were up, and we couldn't put it in a starting position that fit within the 18. Therefore, we decided to move the axles of the conveyor belt up so they wouldn't touch the drive ~~motors~~ motors. We also decided to attach the 1x25's of the wheel-legs higher up on the intake so that they wouldn't interfere with the wheels. The sprocket, which powered the ~~conveyo~~ intake would be exactly on the axles axis of rotation, so it would not slacken either. The new orientation would also allow the robot to fit within the 18.

Continued to page

SIGNATURE

DATE 10/22/12

DISCLOSED TO AND UNDERSTOOD BY

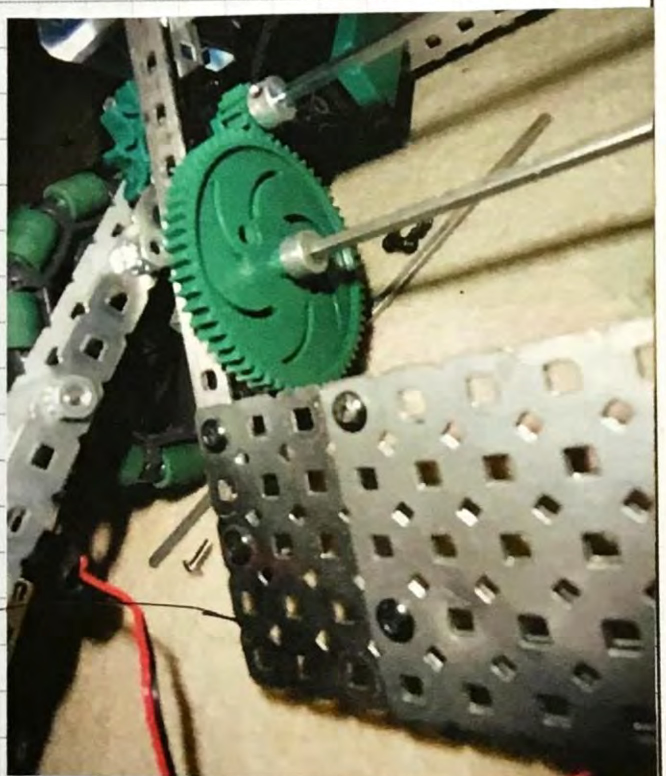
DATE

Continued from page

Finish Conveyor Belt

Today, we finished the conveyor belt at it's 1:5 ratio, but the belt does not go all the way up to the front because we would need two idling gears for it which would cause too much friction. We also added a bar in the middle between the c-channels of the conveyor to give the metal more support. Finally, we added a ramp consisting of a metal plate to the front of the intake so that it could bring sacks to the conveyor belt.

To the left you can see a picture of the belt without the treads attached. As you can see, the six tooth gear's axle is connected to a 6 tooth sprocket. That sprocket will be chained to the roller which is where the motors will be. This way, we can power the ~~intake~~ roller and conveyor belt at the same time with the same motors.



SIGNATURE

DATE 10/23/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Intake Problems

Today, we attached the rollers to the conveyor and tested out the intake. The conveyor belt could easily take five sacks up, but if sacks are stacked, they would start falling and the roller would throw them out. Also, sacks would get caught on the space between the ramp and conveyor belt. Need to keep ratio, but move the conveyor belt up front like it was before. We also brainstormed adding plexiglass to block off sacks from leaving.

SIGNATURE

Continued to page

DATE 10/27/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Belt Work

Today, we worked on moving the conveyor belt up so that the roller would intake directly on to it. We would move the conveyor belt up by adding a rack and pinion gear box to the conveyor, and putting two idling gears inside of it. The rack and pinion gearbox ensures that the axles are supported in two places without having axles going across the intake. We then tested the belt, and discovered that it experiences a lot of friction. We are also worried that two 269 motors may not be strong enough for the intake.

Continued to page

SIGNATURE [signature]

DATE 11/4/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

New Intake

We decided that gearing everything on the conveyor is too complicated. We instead decided to seperately power the intake and wheel-legs. We used low strength chain and sprockets to gear the conveyor belt so that the motor could be ~~more back~~ higher so that it wouldn't interfere with wheels, but still have a high gear ratio. The thinner sprockets of the low strength chain also ensures that the gearing does not take up a lot of space on the intake. We also kept the 1×25's for the wheel legs, but mounted the motor lower so that we could add gearing for torque. We decided that we would be fine using eight high strength motors because other teams do well with 10 393's, and for us, only six 393's will run at one time.

To the left is a picture of the new conveyor belt. A 10-tooth sprocket is chained to a 48 tooth to give a 1:4.8 ratio on the conveyor belt. The roller, wrapped in anti-slip pad to give less space for sacks to get caught on, is geared 1:3 with high-strength gears as shown below. The high gear ratios ensures that the roller has enough torque to push sacks to the conveyor belt, and the belt can pull them back. We also removed the metal support between the linear slide brackets because of space constraints.

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

DATE 11/8/12

Continued to page

Continued from page

Supporting the Belt

Today, we decided that the bucket with the door idea would not be reliable enough for a competition. We decided to make a 17.5" conveyor belt built the same way as the old one but with a support axle in the middle.

We then tested the robot out, and deemed the conveyor belt too shaky. We decided that we needed better support between the two sides of the conveyor belt than a few stand-offs. Therefore, we cut some aluminum to put in between the ~~rack and pinion gearboxes~~ track to add even more structure. However, the conveyor belt links would rub against the metal, so we cut slots into the metal which didn't stop the rubbing. Therefore, we made another axle support with six-tooth sprockets on the top hole near the metal so that the treads could no longer touch the metal.

Continued to page

SIGNATURE

DATE 11/13/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Descoring Ability

Today, we put anti-slip mat on the conveyor belt. However, we quickly realized that if the mat was too tight, the links would bunch up and burst. Therefore, when screwing on anti-slip, you must measure the length around a sprocket of the appropriate size so that the conveyor belt could spin freely. We added a 1x25 to the rack and pinion gear box on the conveyor, and screwed it to the outermost layer of the lift to make a triangle that set our angle. We cut the hole out of one of the 1x25's on each side so that the intake could rotate. When we try to descore, the intake rotates to be flat, making falling sacks come easily onto the belt. However, the belts ~~cutter~~ cannot go over the trough. After the new descoring ability became apparent, we decided to become a robot that would only descore into our own intake and rescore.

Continued to page

First Event

Today, we went to our first New Jersey scrimmage to test out our robot. We found that the conveyor belt cannot outtake sacks out of the back (to solve the height problem), tank treads snap easily, and the anti-slip still rips. To try to prevent ripping, we reapplied the anti-slip mat in smaller portions, making sure to measure distances around the sprocket. ~~Theref~~ However, the anti-slip still rips. Therefore, we decided to replace the anti-slip mat with rubber tank tread links instead which gives enough traction to lift sacks. We also determined that our lift was too slow, so we replaced the 30 tooth gear with a smaller 18 tooth gear for a 1:3 ratio that could still lift a lot.

We then drove the robot around to test it's capabilities. The robot could drive around for over 25 minutes ~~because~~ without experiencing any motor problems. We also did a torque test by pushing our robot against a 6,393 motor, 1:1 drive ratio robot also driving against us. We were able to push the other robot back without experiencing any problems, so the drivetrain works excellently.

SIGNATURE

DATE 11/17/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

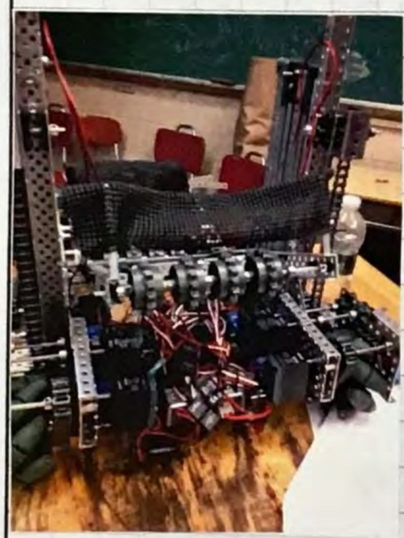
PROPRIETARY INFORMATION

Continued from page

More Intake Edits

Today, we spent some time practicing driving. We also created a back for the intake by adding anti-slip mats to the back, and then zip-ties to keep it in place. This way, we have a light stop that won't interfere with the conveyor belt and would have some give allowing us to fit many sacks. However, we found it had too much give.

We also added a 4th conveyor row and put links on it. After testing it, we found that it could intake well. We also added a back with ~~c~~ c-channels and stand-offs so that we could stockpile sacks. Tested it out, and found that when there are lots of sacks in the back, the intake rotates so that it can no longer intake. Therefore, we added a stop at the back by putting stand-offs at the metal right below the angle at the last c-channel so that the stop doesn't move and the angle stays low enough to intake objects. We also began mounting plexiglass on the side so that sacks don't fall off of the conveyor.



To the left is a picture of the robot with the stop that had too much give. Sacks would just slip under the space on the bottom and still fall out. You can also see the fourth row of ~~treads~~ the conveyor belt, which we added to decrease the space between the belts making it harder for sacks to fall through.

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued to page

DATE 11/22/12

Continued from page

New Motor Mount

Today, because the sacks kept getting caught on the attachment between the 1x25's and ramp, we decided to add another piece of metal to mount the 1x25's upward, so that the roller would come from above instead of from the conveyor. However, we worried that it wouldn't be able to descore as well because the last placement created almost a pinch that forced sacks out. To fix this, we decided to add elastic to the roller, pulling them towards the intake. That way, when the roller enters the trough, it can still create the pinching motion that lets us descore.

To the left is a picture of the new mount of the roller before the rubber bands were added.

Continued to page

SIGNATURE

DATE 11/29/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Strategy Session

Robot will descore opponents trough, re-score in ours, and repeat. Therefore, the robot will be mainly defensive. Descoring and rescoring is an efficient way to score because there are many sacks in one spot, and it causes huge point swings.

However, if opponent tries to play defence, we will:

- Back away from opponent's trough and score in our own.
- Back away until opponent stops defending, go back and descore
- Travel around the field picking up sacks - play offensively
- Try to alliance with quick scoring partners.

Opponents could possibly stop scoring in troughs to counter strategy. If so:

- Concentrate on scoring own troughs
- Play defense against floor and high goals.

Continued to page

SIGNATURE

DATE 12/3/12

DISCLOSED TO AND UNDERSTOOD BY

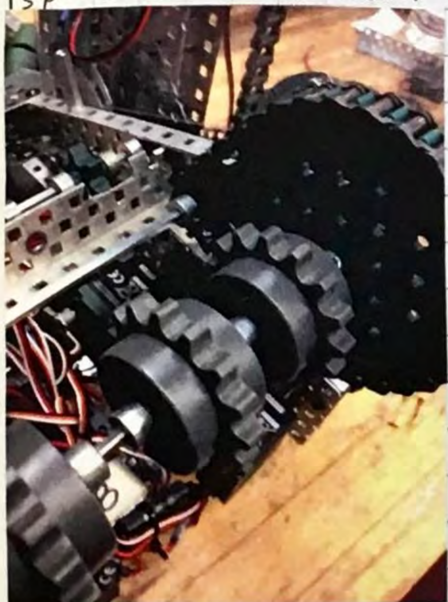
DATE

PROPRIETARY INFORMATION

Continued from page

Intake Upgrades

Today, we moved the conveyor belt motor to the back of the intake because while it was at the front, it scraped on wheels, and touched the trough while descoring. We also found that the low strength chain that powers the conveyor belt could snap really easily, so we powered the conveyor belt with a 6 tooth high strength sprocket to a 30 tooth high strength sprocket as shown below. We also created a flip down, triangular wall on the drive train as shown to the right.



We wanted a flip-down wall so that it could extend past the 18, and we made it with 1x25's because they can easily be shaped into triangles. We hope to use the wall to expand the width of our intake. By driving towards sacks that would normally go towards the wheels, we could intake them because the sacks would slide across the plexiglass wall.

Continued to page

SIGNATURE

DATE 12/4/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

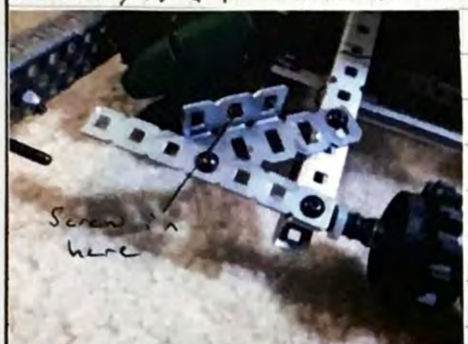
PROPRIETARY INFORMATION

Continued from page

Intake Testing

Today, to ensure that our robot could possiby go under the trough, we lowered all the upper linear slide delrins by one hole because we found that they hit the trough.

We then tested out the intake again, and discovered that the sacks could still get caught on the ~~wheel~~ 1x25's of the roller. Therefore, we decided to create a new plexiglass wall that would branch from the intake and go under and around the wheel-legs, ensuring that sacks would no longer get caught on the 1x25's. Below, is a picture of the mount for the plexiglass, it would screw



into one point on the angular metal, and then bend around the point where the wheel legs are attached. The plexiglass must be cut in a specific shape so that it doesn't impede the roller from coming all the way down.

We then tested the intake while someone placed their hand at the back to act as a stop. We found that we could easily ~~pick up~~ intake 15 sacks. However, once we tried lifting, the first stage would go up easily, but the second stage would start clicking when we tried to go up further. After studying the problem, we noticed the sprocket attached to the motors by chain that moved the lift was bending inward because of stress. We therefore added a rail to the side connected to the base that would act as another support for the axle so that it could support the weight

Continued to page

SIGNATURE

DATE 12/5/12

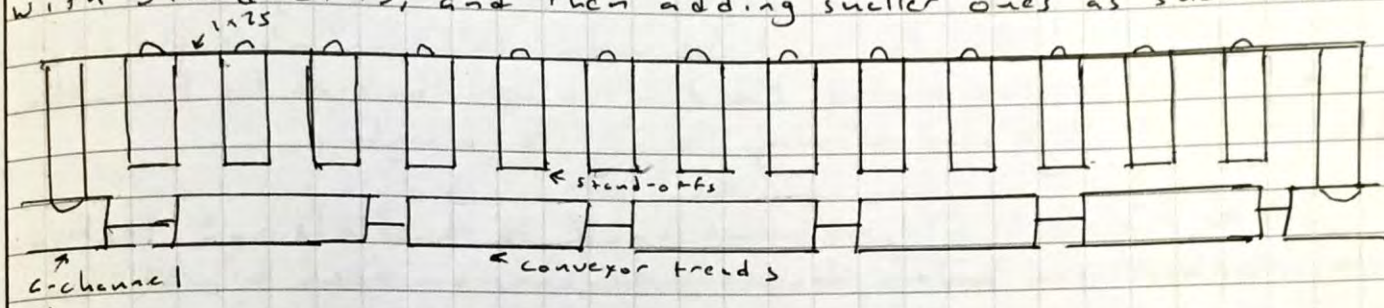
DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Re-Mounting Rollers

Today, we added a back to the conveyor belt by mounting a 1x25 to the last hole of the c-channel with stand-offs, and then adding smaller ones as shown below:



With this stop, we can prevent sacks from falling out of the back without worrying about the stop touching the conveyor belt.

However, when we tested the intake again, we realized that sacks could still get stuck on the angle created by the 1x25's attached to the roller and the conveyor belt itself. We then realized that the only way to stop the sacks getting caught would be to eliminate the angle between the 1x25's and the conveyor belt, and the only way to do that would be to raise the 1x25's. Therefore, we added L-bars to the conveyor belt, and put the 1x25's high up on it so that the rollers would come from above, giving the sacks nowhere to get caught on. We also added a stand-off to the L-bar to prevent the roller from going too far forward, and rubber-bands going from the 1x25's near the roller to the conveyor belt so that there would be pressure on sacks.

Continued to page

SIGNATURE

DATE 12/10/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Penn State Abington Scrimmage

Today, we went to the Penn State Abington Scrimmage to see how our robot would do against others. We tried to score with our robot first, but discovered that we could not reach the trough with the lift while still having the robot be under 15-inches while the lift is down. Therefore, we moved the delrin's up a hole on the top, making the robot taller, but also allowing the lift to go higher.

After fixing the lift, we went back to the field and tested the robot but some ~~more~~ more. However, whenever we tried to pick up more than 10 sacks, the towers would start to break off as shown:

After discovering the problem, we realized that the design would not work. We made the lift with the plastic delrins facing forward, so it depends on the plastic holding up to work. However, when the conveyor has lots of sacks on it, and starts going up, the weight, focused mainly on the front, becomes too much for the plastic to handle, causing it to give out and render our lift and intake useless. The only solutions would be to not pick up many sacks, move the lift so that the delrin's faced inwards, or build a mechanism that would prevent the delrins from giving out. However, the first solution would decrease the bot's offensive capabilities, the second solution would require a major redesign and the third one would still not solve the problem of the lift falling out. Therefore, we debated the pro's and cons of staying with the current lift or building a 6-bar.

Elevator Lift		6-bar	
Pro	Con	Pro	Con
-Lifts a lot -Stays up without motor power -Constant center of gravity	-Requires major redesign to work -Very slow -Heavy	- Lifts a lot - Fast -Dependable -Wide intake possible	-Major re-design -Needs motor power to stay up. -Can flip

Continued to page

SIGNATURE

DATE 12/15/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

New 6-bar Plan

Today, we looked at the pros and cons of the two lifts, and decided to build a 6-bar because it would make the robot much more efficient. Therefore, we planned out a new drive-train and lift that would allow us to keep the modularization of the lift and drivetrain.

We realized that if we took the current lift off and moved the modularized gear-boxes forward two holes, there would be spaced in the back for towers. We decided to use 12 inch aluminum rails because they could screw directly into the channel. We then realized that ~~the~~ the rails and the modularized gear-boxes make a right angle, letting us put an L-bar there easily. That way, the towers would be supported in two spots.

However, to keep the same lift modularization the 6-bar would have to be powered the same way as the elevator: using high-strength chain and sprocket. Therefore, we decided to only power the bottom arm of the 6-bar so that we could have room for a compound gear ratio of 1:15 (1:5 to a 1:3). Sketches of the design are on the next page.

Continued to page 52

SIGNATURE

DATE 12/16/12

DISCLOSED TO AND UNDERSTOOD BY

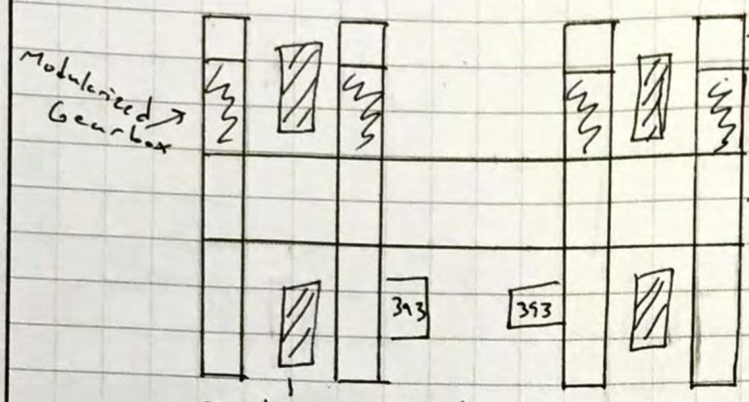
DATE

PROPRIETARY INFORMATION

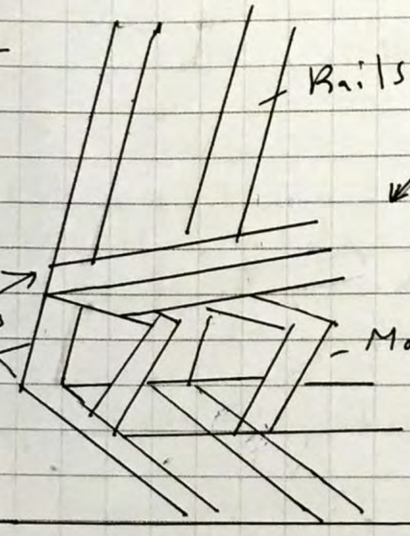
Continued from page 51

6-Bar Conversion Sketches

Drive Changes (Bird's eye View)

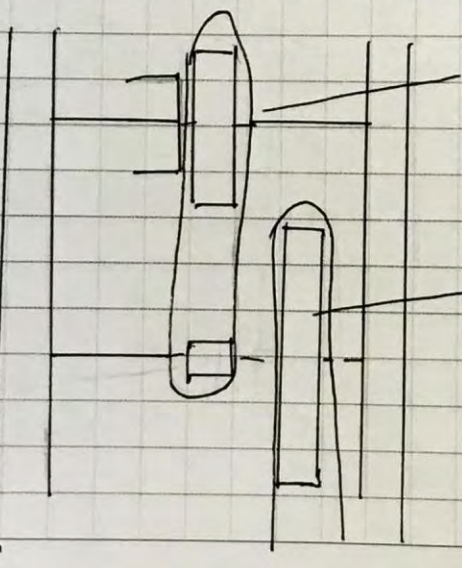


Tower Attachment (1 side)



Lift Gearing!

$$\begin{array}{r} 1:5 \\ \times\ 1:3 \\ \hline 1:15 \end{array}$$



18 tooth sprocket chained to the compounded 6 tooth. This sprocket is screwed to the bottom of the 6-bar.

30 tooth high strength sprocket chained to the two 6 tooth sprockets connected to the motor (1:5)

6 tooth sprocket compounded to the 30 tooth, chained to the 18 (1:3)

SIGNATURE

DATE 12/16/12

Continued to page

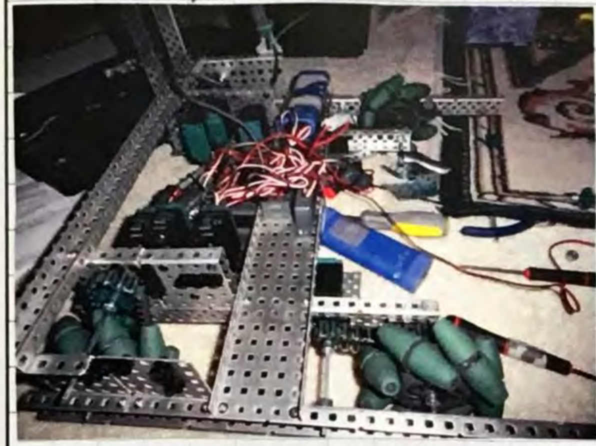
DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

New drive + lift Base

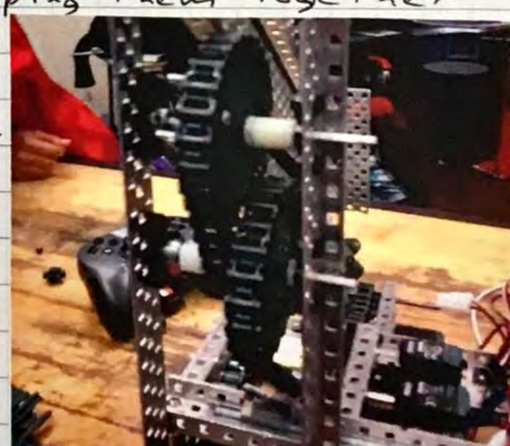
Today, we started to build the new 6-bar robot by first



taking off the lift and then restructuring the drivetrain to make it look like the picture to the left. However, we ended up using a c-channel instead of an L-bar for the second rail support because the L-bar would not fit.

We then added the rails and began to create the gearing needed from the arm. However, as shown below, the chain does not have a lot of tension against the right sprocket on the lift motors since ~~the~~ it was designed for a lift that had the sprocket right above it. Therefore, we moved the sprocket down so that it would have more contact with the chain. We also mounted the vex net on the gear-box because it is not surrounded by metal and would not effect anything.

We then attempted to gear the lift 1:15 as described before, but discovered that the 30 tooth sprocket would not fit under the six bar which we assembled with a 35 hole c-channel, two 25 hole c-channels, and a cut rail keeping them together in the middle. Instead, we geared the motor sprockets to a 24 tooth sprocket (1:4) and the compounded 6 tooth sprocket to another 24 tooth (1:4) to make a 1:16 ratio. Although ~~a~~ 1:16 is a bit slower than a 1:15, it is a bit more powerful which we like.



SIGNATURE

DATE 12/17/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Building a Bigger Intake

Today, we started to build the new intake. We first made a rectangle out of two c-channels and two rails. The c-channels are 35 hole for a long conveyor and the rails 12 inches wide. By making ~~a~~ rectangle, we ensure that the axles won't have to support the two sides of the lift and it stays stable as shown ~~to~~ the right. We used small, 6 tooth sprockets so that we could use less tank tread, and we added a support axle in the middle with 12 tooth sprockets on the bottom hole. We also used spacer between the sprockets to ensure exact distances and to decrease our dependance on collars.

We also noted that 4 wheel-legs would not make a 12 inch wide roller, Therefore, we used sprockets with stand-offs attached to widen the roller without making us buy more wheel-legs. As you can see in the picture to the left, the stand offs are positioned differently from the wheel legs. This way, the intake will touch sacks more per rotation.

We then measured the robot and found it to be over 18 inches long. To fix the problem, We replaced the outer two 35-hole c-channels with 25 hole, and then added metal to the bottom of it. This way, the robot will fit within the size limit, and the rail sticking out of the bottom of the drive train will ensure that the robot does not flip forward.

SIGNATURE

Continued to page

DATE 12/22/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

High Goal Scorer

Today, we went on Vexforum.com, and saw 4886A's high goal descorer which consisted of a platform on the back of the conveyor belt. It could rotate, and it was attached to the base by ~~stope~~. The team would stack their match-loads onto the platform, and back into the high-goal at which point the lift would raise to full height. The raise would cause the rope to tense up, pulling the platform up and depositing the match-loads into the high goal.

We wanted to make something similar so that our robot would be able to score on all goals. We designed a platform with a cut c-channel, rail and L-bar so that sacks would have plenty of room to rest as shown in the picture to the right. We also added cut 1x25's to the ~~c-channel~~ L-bar so that sacks would not be able to fall out. They would also theoretically descore the high goal if the tension of rope can cause the 1x25's to clamp down on sacks with pressure.

Continued to page

SIGNATURE

DATE 10/23/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

Fixing tension, mounting belt

Before, we had an L-bar at the end of the 6-bar to mount the intake to. However, the only way we could have a flat surface to mount the intake to with the L-bar would be to make the L face inwards, which makes the bar interfere with the L. Therefore we decided to mount the intake straight to the lift. To do this, we added a cut rail to the sides of the conveyor belt to expand the surface area of holes available to mount the bar on. We experimented with rail placement until we reached a spot where we could mount the intake at an angle that doesn't touch the wheels. We put spacers in between the 6-bar and intake so that the 6-bar would not bow out.

We then tested out the lift, and noted that the chain clicked a lot. In order to tighten the chain, we added stand-offs for tension. However, this causes friction with the chain, and could get unscrewed easily. Instead, we decided to replace the compounded sprockets with gearing so that there would be less chain in the lift, and less chances for bad tension. We then added a stop for the 6-bar by attaching a stand-off to the bottom bar that hit the middle c-channel and stopped the lift from going further down.

Continued to page

SIGNATURE

DATE 12/26/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Trouble with Stops

Today, we attached the wheel legs to the conveyor using the same 1x25's screwed together as before. We kept the 1:3 gearing of the wheel legs, and mounted the 1x25's to the cut rail. We then tried to create a stop by attaching spacers to the 1x25's, but as you can see to the ~~left~~ right, it stops the robot from fitting into the 18" in the beginning.

We then realized that the high goal scorer ~~was~~ too heavy, so we took it off and instead mounted the stop to the towers so that sacks couldn't fall out of the back while intaking, but we could score in the 30" out of the back of our conveyor belt.

Finally, we started to design a whellie wheel to ensure that the robot would not ~~slip~~ flip. We put a 2.5" omni-wheel inside a linear slide bracket and put it on a hinge. That way, when the robot flipped back, the wheel would also go back and prevent the fall. However, we tested the stop out, and found that the omni-wheels only helped cause the robot fall, so we replaced it with a high traction wheel.

SIGNATURE [signature]

DATE 12/27/12

Continued to page

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Scoring out the Back

Today, we tried to fix the problem of the roller stop fitting within the 18" cube of space we experienced yesterday. To do so, we added a spacer on the c-channel near the cut rail so that the 1x25's would hit it and keep a consistent angle for the intake.

We also had another hinge, so we decided to use that for the stop of the conveyor belt. With the previous set-up, sacks descored from the trough could possibly fall out of the back. With the new set up, an aluminum plate is attached to the back only by a hinge screwed into the support rail on the back of the conveyor belt. We realized however, that the stop would have to come back up, so we added stand-offs to the metal ~~of~~ c-channels of the conveyor belt, and attached elastic from stand-offs sticking out of the metal plate to the stand-off on the c-channel. That way, elastic would keep the metal plate up, and when we finished ~~d~~scoring, the plate would snap back into place. In order to make the plate go down, we would attach rope to the plate going down to the base. That way, as the lift raised, the rope would tense up and cause the plate to go down.

Continued to page

SIGNATURE

DATE 1/3/13

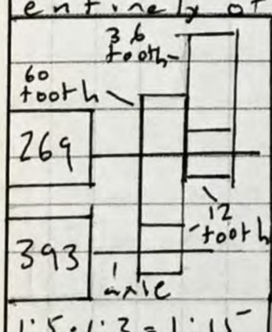
DISCLOSED TO AND UNDERSTOOD BY

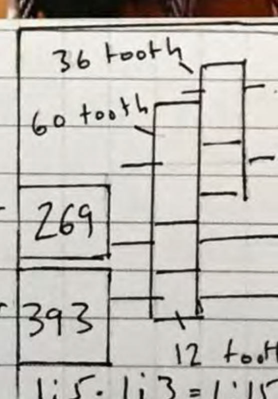
DATE

New Gearing

Today, we realized that the tension of the lift chains were different on the two sides of the lift even though they had the same amount of links. We measured the distance from sprocket to sprocket, and realized that the two sides were about a quarter inch different in length. Therefore, we combed the robot for any differences on the two sides. We noticed that the gear box was made of different metal - one side was made of a 1×5×35 hole c-channel cut in half, while the other was made of a 1×5×35 c-channel cut into four pieces. We therefore moved the metal around to make sure each side ~~was~~ is symmetrical.

We then tested the lift, and found that the axle would start to bend if we used it as shown to the right. The high-strength gear also broke. We decided that the tension from the chain caused the snapping axles, so we decided to change to a lift comprised entirely of gearing. We designed a 1:15 gearing like the one shown to the left because it would be simple and compact. However, we then realized that it would make the two motors spin at different speeds, destroying them. We then decided to make a new lift gearing like the one shown to the right. This way, both motors will spin the same speed and we can still have a 1:15 ratio. However, when we tried to put the motors on, we discovered that the motors would not fit in the space between the 12-tooth sprockets. Additionally, the bottom of the ~~six~~ 36 tooth gear would touch the bottom of the 6-bar after we switched the 60 and 36 tooth gears around to make room for the six bar.





Continued to page

SIGNATURE [signature]

DATE 1/7/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Fixing Gears; Spacing

Today, we decided to keep the gearing from yesterday, but we ~~would~~ added a 60 tooth idling gear in between the powered 12-tooth sprockets. This way, we would not have a problem with motors being too near each other. However, the bottom motor would not fit because it was too close to the support c-channel. Therefore, we moved all the gearing over one hole and down so that everything would fit as shown to the left. With the new gear ratio, the spacing in front is wider, requiring more spacers. However, we feared that having too many space would weaken the attachment, so we put a c-channel in between the conveyor belt and the 6-bar.

To ensure that the spacing on the tower is consistent with the front, we placed a c-channel in between the back of the 6-bar and the conveyor belt therefore making sure we could easily space the lift out. We also collered the lift so that if we removed the rail with the motors on it, the axles would stay put because there are collers on the inside corner and outside edge. Therefore, we can still have a modularized lift. We also added a cut 1x25 in between the two towers so that it would not spread apart.

Continued to page

SIGNATURE

DATE 1/10/12

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Intake Work

Today, we tested the intake and found that sacks would get caught in between the 1x25's and stand-off's while intaking because the 1x25's were too close to the ramp. Once again, we must make the roller come from the top. We found that we had more cut 1x5x35 hole c-channels, so we replaced the cut rail that we used to mount the conveyor belt to the 6-bar with one. This gives us more holes to work with as far as angles go. To attach the roller from the top, we screwed the 1x25's onto another cut 1x5x35 hole c-channel and attached it to the c-channel. We also put a long stand-off bar in-between the 1x25's so that they wouldn't move around. Finally, we put screws underneath the mounting point of the 1x25 rollers to act as a stop for the rollers.

We then took the cut rails removed from the conveyor-lift attachment and mounted them to the bottom of the lift c-channel so that they hit the large support c-channel and act as a stop for the 6-bar. Finally, we took an aluminum 1x2x35 hole c-channel and attached it across the bottom of the 6-bar to make sure that the 6-bar stays together.

Continued to page

SIGNATURE

DATE 1/11/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Unplugged Motors

Today, we realized that the metal sticking out of the front of the drivetrain that stops our robot from flipping forward digs into the field too much. Therefore, we added a bearing to the end with one hole sticking out so that the plastic bearing would hit the field rather than the sharp metal. We also tested the high goal scorer by trying to intake out of the back. However, near the back the chain begins to sink, therefore preventing sacks from leaving out of the back. Therefore, we put the stand-off of the conveyor belt up one hole so that the treads would not sink as much.

We also tested the lift with 20 rubber bands on each side. With this configuration, the lift could go up by itself, but the addition of any sacks made the lift click. We therefore removed the idling gear and the 12 tooth above it to make sure the motors were spinning. We then realized that two motors got unplugged because of bad wiring. Therefore, we plugged the motors back in and organized/ziptied the wires so that motors would not unplug again.

Continued to page

SIGNATURE

DATE 1/15/13

DISCLOSED TO AND UNDERSTOOD BY

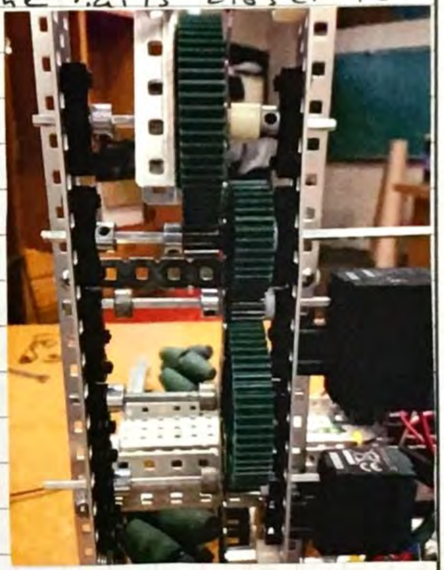
DATE

Continued from page

Axle Supports

Today, we found that the gears kept on skipping. We researched the causes of gears skipping and found that it is caused by wide axle supports; when axles are supported closely, motor's die. When axle supports are wide, the gears slip when the load is too much, with the skipping caused by the axles moving away from each other. We also decided to move the gears closer to the motor so that the axles have less to turn before reaching the gears. The closer spacing leaves the c-channel between the lift and conveyor belt unnecessary. Therefore, we removed it and used spacers instead.

Unfortunately however, we cannot move the rails closer together, so we instead placed a 1x25 in between the compounded gears attached to the rails by standoffs. Through this, we hope to split the axle length in two artificially, as you can see in the picture to the left. We also re-attached the wheel less by putting the 5x5 square c-channel on top of the other one letting us intake from the top still as shown below. Finally, we put a potentiometer on the top lift arm.



-Another view of the 1x25 added to the gearing

Continued to page

SIGNATURE

DATE 1/17/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Faulty Cortex

Today, we decided to change the roller to be geared 1:1 so that we could intake faster. However, while the fast roller can pick sacks up faster, it can also dump sacks out easily while intaking. In order to retain the fast intaking ability while lessening the amount of sacks getting dumped out, we geared the roller 1:2 using a 6 tooth sprocket driving a 12 tooth one as shown in the picture to the right. We also changed the position of the stand-offs on the sprockets so that they lined up with the wheel-legs. This way, the roller will have less places to get stuck on sacks.

We then tested the intake, and found that the conveyor belt would only go up. We inverted the motor controller and found that the conveyor only went down. Since the motor was able to spin both ways, we deduced that we didn't have a faulty motor. Our programmer then checked the code and found nothing wrong with the programming. After that, we switched the motor ports of the conveyor belt and roller. Once we did this, we found that the roller only went in one direction. Therefore, we deduced that a faulty port 10 was causing our problems. We also made the programming ~~fo~~ changes featured on the next two pages.

Continued to page 65

Continued from page 64

Programming

New Features

- LCD Screen
- Potentiometer
- Quadrature Encoders
- Motor Slew Rate

LCD Screen

The addition of our LKD screen allows for us to configure many aspects of the robot and gain a diagnostic insight to its current workings. We use it to configure our autonomous programs when the robot first starts up. This can be seen in the code sample to the left. In addition, we use the screen to display the voltage of the main battery and of the power expander battery. The voltage of the power expander battery can be retrieved through the status port.

```
pre_auton() {
    if (! bIfiRobotDisabled)
        return;
    bLCDBacklight = true;
    StartTask(selection);
    while (! done) {
        if (! bIfiRobotDisabled)
            done = true;
        wait1Msec(25);
    }
    StopTask(selection)
    bLCDBacklight = false;
}

task selection() {
    done = false;
    ...
    done = true;
}
```

Motor Slew Rate

We also implemented a motor slew rate. What this does is gradually changes the values sent to the motor, as opposed to immediately changing them. This is accomplished by spawning a background slew task in RobotC that is

Continued to page 66

SIGNATURE [signature] DATE 1-22-13

DISCLOSED TO AND UNDERSTOOD BY DATE

PROPRIETARY INFORMATION

Continued from page 65

Programming

responsible for adjusting the values of the motor. Here is some basic pseudocode ~~for~~ for a single slew rate.

The potentiometer added ~~were~~ was intended for use as a limit switch. It ensures the arm is only allowed to move in the reasonable range of motion, so as not to strain the motors.

```
task slew() {
while True{ for each motor
        if requested[motor] < motor[motor]
            motor[motor] += slew;
        else if requested[motor] > motor[motor]
            motor[motor] -= slew
    }
    wait1Msec(25);
}

start Task(slew);
requested[motor] = 127;
```

The quadrature encoders are used for measuring ~~distance~~ rotations (θ) traveled on the wheels. This is for autonomous mode and ~~has~~ has not been implemented yet.

Continued to page

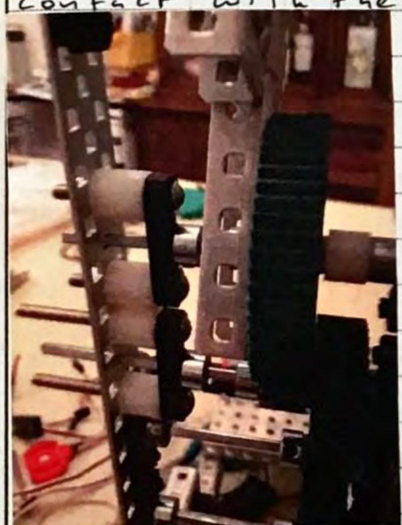
SIGNATURE [signature] DATE 1-22-13

DISCLOSED TO AND UNDERSTOOD BY DATE

Still Skipping

Today, we replaced our faulty cortex with a fully functional one. However, we found that the mecanum wheels would not strafe correctly. After studying it closely, we found that chain hit the wheels as they spun, so we fixed the spacing to minimize friction on the drivetrain, but it still would not work. We also added flaps and mesh to the intake so that the intake could still exert pressure on sacks, but there would be less space for sacks to rest in.

However, the lift still couldn't go up much without skipping. We then realized that the 1x25's ~~fo~~ did not help much since they don't have contact with the axles. Therefore, we decided to add bearings



with ~~stand~~ spacers as shown to the left instead of the 1x25. We believe that the bearings will work since they have a circular inside that comes in contact with the axle.

Continued to page

SIGNATURE

DATE 1/25/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

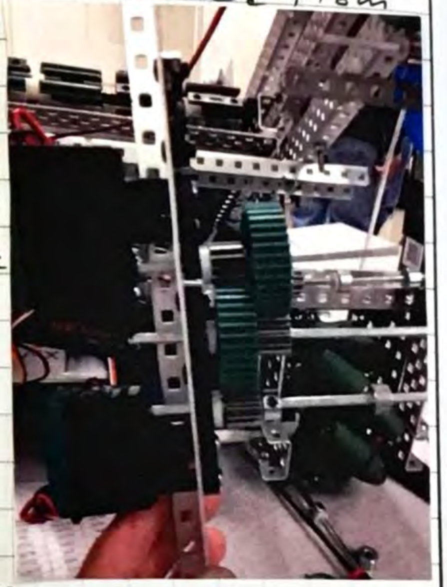
PROPRIETARY INFORMATION

Continued from page

Dockbots

Today, we went to the Dockbots competition in Pennsylvania, where our lift still didn't work. Additionally, during the event, we accidently broke the motor pins for the roller 393, so we had to replace it with the only motor we had - a 269. However, during the tournament, we realized that the mecanums would not strafe because the front two mecAnums were mixed up. Once we fixed the issue, we were able to strafe well. We also converted the conveyor belt from using 35 hole c-channels to 25 hole in order to reduce weight, but the lift still couldn't handle it.

We spent the rest of the tournament either playing defensively (blocking or descoring) or trying to pick up a few sacks at a time and scoring them. We spent the rest of the tournament brainstorming ideas to fix the lift. We decided that the problem occured from too much torque going through the componnded axle. We tried to implement gearing like the one to the right that would prevent slipping, but space constraints prevented us from doing it. We then decided to just do a simple lin lift with four high strength motors to reduce the torque traveling through the axles.



We did not get picked for eliminations, but we did learn the importance of descoring. ACME robotics was able to dominate the competition because of their ability to quickly descore and rescore large amounts of sacks. We hope our robot will work similarly when fully functioning.

Continued to page

SIGNATURE

DATE 1/26/13

DISCLOSED TO AND UNDERSTOOD BY

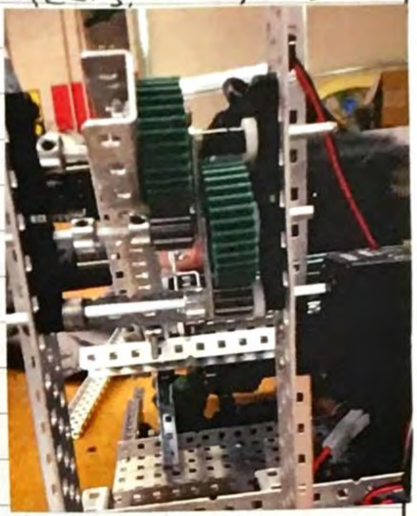
DATE

PROPRIETARY INFORMATION

Continued from page

New Gearing, Support

Today, we created a 1:9 lift using 12 and 36 tooth gears compounded to another set of 12 and 36 tooth gears. We placed lock plates in between the gears so that the axles can't spread themselves apart. Today we also added a c-channel to the rail tower by screwing stand-offs into it and attaching the c-channel to the support c-channel spanning all the rails. Through this, we can have narrower axle supports without sacrificing the stability that the rails give us. We then had driver practice.



However, while driving, we noticed the treads hitting the metal. We decided that there was too much slack on the treads so we took off the tank treads and saw the axles bending inwards. We then realized that the axles needed more support, so we added two 1x25's in between the stand offs with bearings at the end to shorten the axle supports and prevent further bending.

SIGNATURE

DISCLOSED TO AND UNDERSTOOD BY

DATE

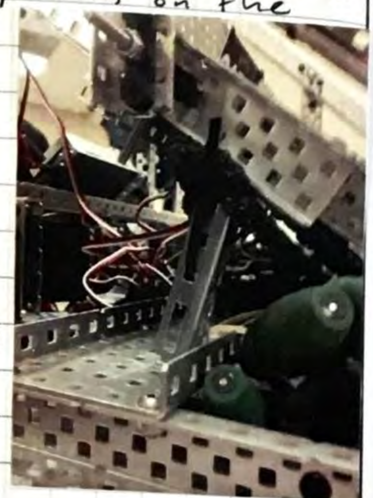
Continued to page

DATE 1/29/13

PROPRIETARY INFORMATION

No more Compounds

Today, we tried to lift 5 sacks with the 1:9 ratio, and the gears started clicking again. We decided that any type of compound gearing would be too complex causing gears clicking. We therefore switched to a 1:7 gearing, the highest gearing possible without compounding, by gearing the 12 tooth ~~sprocket~~ gear to two 84 tooth ~~sprockets~~ gears screwed together. With this simpler lift, we can easily lift over 10 sacks. However, the stop we currently have on the lift hooks into the trough while scoring or descoring. Therefore, we took off the rail on the lift and put it on the support c-channel. However, we feared that having a straight rail as the stop would not be reliable since it could bend under pressure. Therefore, we bent the rail to be perpendicular to the lift so that the energy would be transferred to the large c-channel. We also added anti-slip matting over the rail to prevent scratching the metal.



However, the new gearing makes the intake very close to the arms of the lift causing it to get caught on the lift. To fix this, we added a spacer to all the spacing of the 6-bar.

Continued from page

PA Championships

Today, we competed in the Pennsylvania championships where our lift worked perfectly. However, the conveyor belt could not lift more than 3 sacks up the ramp. We realized that sacks would slip down because the angle was too steep. We also changed the roller to have smaller stand-offs sticking out of 30 tooth sprockets, giving sacks less room to fall off while also allowing the intake to go deeper into the trough.

Even though we could not intake much, we competed, first going for the gold sack underneath the trough and the group of five near it during a match. We spent the rest of a match either trying to score or descore depending on the situation. Even so, we ended with a 5-2 record, making us the alliance captains of the 7th seed alliance. We searched for robots that could score well, while we descored. We debated over 24A, who had a working robot similar to ours and 12M who we worked well with in our last match and who had a fast scoring linear lift. We watched 24A's last match to see their performance, and noted that while their robot was great, their performance was lacking.

Therefore, we chose 12M as our first alliance partner and 889A, a top-roller that could score well for our alliance. Unfortunately, we lost in the semi-finals to the alliance led by 12P. However, during the competition, we learned what we need to do to perfect our robot.

Continued to page

SIGNATURE [signature]

DATE 2/2/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

V3 Design

Today, we came together and designed a new drivetrain and roller for the robot. We designed the drive with the mindset of giving us enough room for a low intake, and the roller with the goal of making a strong, round roller that could easily descore troughs.

We decided to restructure our drivetrain so that the mecanum wheels would be at the back, once again modularized to the gearbox, and we would replace the large 1x5x35 c-channel spanning the drive for support with a 1x2x35 c-channel making the back as compact as possible. To prevent the robot from tipping forward, we ~~added~~ would add dummy 2.5" omni-wheels to the front inside linear slide brackets.

For the roller, we would have two 30 tooth sprockets covered in treads with holes. There will be 1x25's screwed to the tank treads at specefic intervels of 2 between, then 3, so that the whole roller could contact the sack while having some give. We would then cover it with some white anti-slip matt followed by black ones to help pull sacks in and for aesthetic awesomeness

SIGNATURE

Continued to page

DATE 2/3/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Changing Drive, Strengthening Belt

Today, we started on the design described on the previous page. However, rather than making the 2x1x35 on the outside be exact, ~~we placed~~ against the rails, we placed them two holes back so that it wouldn't be longer than 18'' since we have the 84 toot gears sticking out and we don't want to cut metal. It also makes it easy to create a wheelie bar if needed. We then moved the mecanum wheels back.

Then, we started working on the conveyor belt. We found the chain too loose, so we moved the axles farther apart to tigthen the links. We also added 3 more stand off supports making the 6 tooth tensioner sprockets unnecesarry, and makes the conveyor belt straight and reliable.

Continued to page

SIGNATURE

DATE 2/4/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Roller

Today, we fixed the lift towers to only be two rails like before and put new axles on the lift. We then added the dummy wheels to the front of the drivetrain. However, we quickly found that the dummy wheel goes higher than the two mecanum wheels so that the front two wheels did not touch the ground. Therefore, we took them off and thought about adding 4-inch omni wheels to the front instead, but we don't have room for it.

We also created the roller described on page 72 by laying the treads down and ~~addittle~~ adding the 1x25's and then wrapping the treads around the sprocket. However, we found that the two sprocket configuration had too much give, so we added one in the middle to provide some rigidity.

Continued to page

SIGNATURE

DATE 2/5/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

New Wheel, Coupler

Today, we tried to solve the problem of the dummy wheel being too high. We took off the linear slide bracket and looked to see if we could attach the wheel another way. To mount the wheel, we placed it on the bottom hole of the outermost drive c-channel, and added a small c-channel bolted to the support c-channel as shown to the right to make a new wheel position in front. However, the wheel does not touch the ground. Rather, when the robot tips forward, the wheels will stop it from falling all the way so that we could still right ourselves.

We also attached the power-expander and back-up battery holder to the support c-channel. We then put treads on the conveyor belt and tried to attach the roller to the intake. However, a 12 inch axle

was not long enough to span the length needed, so we coupled a long axle with a shorter one as shown to the left. We have collars around the couplings to keep the axles still. However, with just the collars we realized that the axles could easily split apart. Therefore we screwed the whole contraption to the sprocket using a lock bar and some stand-offs/spacers.

Continued to page

SIGNATURE

DATE 2/6/13

DISCLOSED TO AND UNDERSTOOD BY

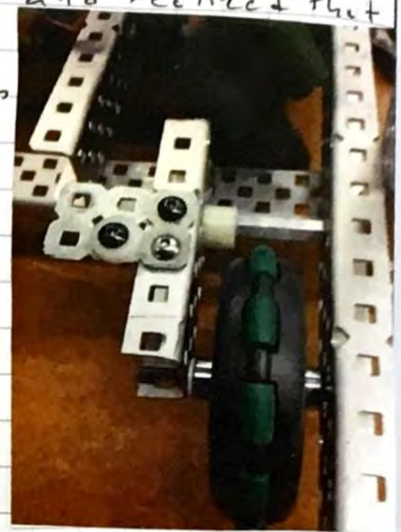
DATE

PROPRIETARY INFORMATION

Continued from page

Added Wheel, Roller

Today, we tested out the conveyor belt, and realized that treads were hitting the support c-channel. Therefore, we mounted the c-channel to the bottom of the drive train where it could still give the same support as before. This allows us to have a steeper angle for the intake.



We also finished wrapping the intake roller and added it to the robot using L-bars. We positioned it to be as close to the ground and conveyor belt as possible so that it could quickly intake sacks while spinning freely. We also added a stop for the conveyor belt by putting a 2x6 piece of metal with a spacer screwed to it on the front wheel support c-channel.

Continued to page

SIGNATURE

DATE 2/7/13

DISCLOSED TO AND UNDERSTOOD BY

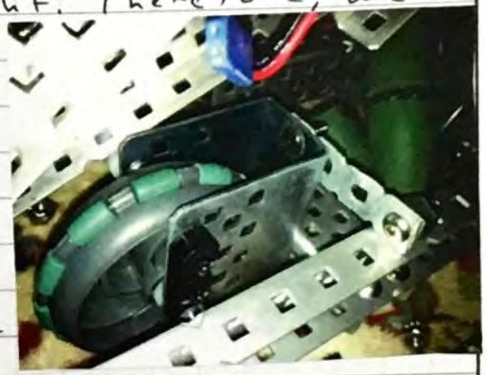
DATE

PROPRIETARY INFORMATION

Continued from page

Better Wheel Mount, High Goal

Today, we looked at the new placement of the support c-channel and realized that we could attach a ~~support~~ ~~ext~~ linear slide bracket there with a small omni wheel. Therefore, we put the omni-wheels into the linear slide bracket again and mounted it to the support c-channel. We got the wheel very close to the ground, but with only one ~~whee~~ screw attaching the bracket to the c-channel, the wheel could sway from left to right. Therefore, we tried to use angular c-channels and gussets to screw into the c-channel and bracket, but none of the holes lined up. However, we realized that we could screw a collar into the metal c-channel, which would give a mount for another piece of metal. We mounted a cut 1x25 between the top hole of the linear slide bracket and the collar as shown to the right.



We also wanted to create a high goal scorer again, so we put standoffs and a collar on the two sides of an aluminum plate, and screwed the collars onto the conveyor belt for the back of the intake. We then added a cut c-channel on a hinge to the top of the stop so that we could score the match loads through tension of rope. We also added stand-offs to the bottom screws of the hinge to set the scorer at a slightly forward angle. That way, if sacks fall, they would fall into the conveyor belt. However, sacks shouldn't fall because we screwed in a long angled piece of metal to the ~~back~~ front of the scorer ensuring sacks stay put.

Continued to page

SIGNATURE

DATE 2/9/13

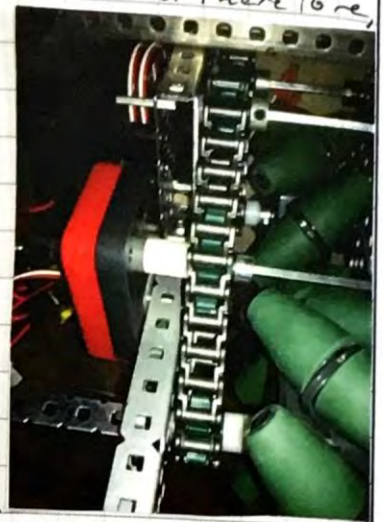
DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Open House

Today, we attached shaft encoders to the drivetrain to help us make an autonomous later. We noticed that there was space between the motor and the front wheel where we could put a tensioner sprocket in between the chain powering the front wheels. Therefore, we mounted the encoder to the inside portion of the drivetrain, and put pillow blocks on the other side to support the axle. We then tried adding a 12-tooth sprocket, but it was too loose. When we tried an 18, it wouldn't fit. Therefore, we took a 15 tooth tank tread sprocket and cut the plastic off of one side of it to power the shaft encoder.



Today was also the 8th grade open house at Cherry Hill East, so we set up a table and drove around ours and 2616 F's robot to draw attention. While driving around, we found that the robot could intake very well, but sacks would occasionally get stuck on the 1x25 we put on the front of the intake, so we took it out. Also, at one point, the back left motor went out but we kept going. We will figure out why next meeting

Continued to page

SIGNATURE

DATE 2/13/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

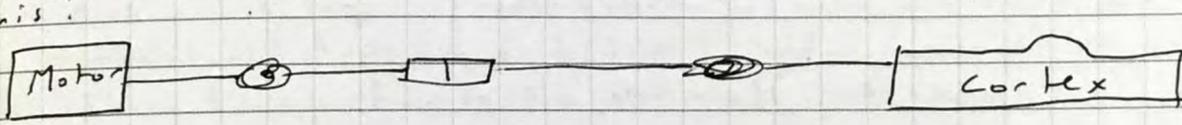
Continued from page

Wiring

Today, we evaluated the problem with the drive train. After flipping the robot over, we took the drive motors off, and ran it to see if the motors spun. The back left motor wasn't spinning. to determine the cause, we did the following:

Action	Conclusion
-Checked that motor plugged in	-Know problem not bad connection
-Swapped out motor controller	-Problem not bad motor controller
-Tried motor in another port	-Not a broken port, motor broken

After doing this, we took off the motor, and saw that the wire was coming out. We realized that this happened because the battery would push up against the wire, causing pressure that broke the wiring. Therefore, we redid the wiring so that the batteries could be placed into the ~~cortex~~ robot without damaging wires. We also ziptied the wires like this:



With a ziptied bundle before and after the connection in the middle, preventing us from having excess lengths of wires hanging around, and allows us to disconnect and reconnect wires easily. After this, we added elastic to assist in lifting.

-A picture of the new wiring

Continued to page

SIGNATURE

DATE 2/14/13

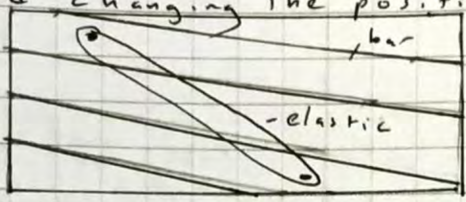
DISCLOSED TO AND UNDERSTOOD BY

DATE

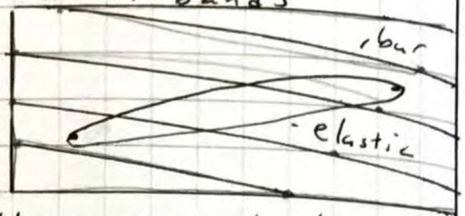
Continued from page

Preparing for South Brunswick

Today, we tested the robot for the competition at South Brunswick tomorrow. We noticed that the elastic we added caused the conveyor belt to slope more steeply than usual. We considered changing the position of the rubber bands from this:

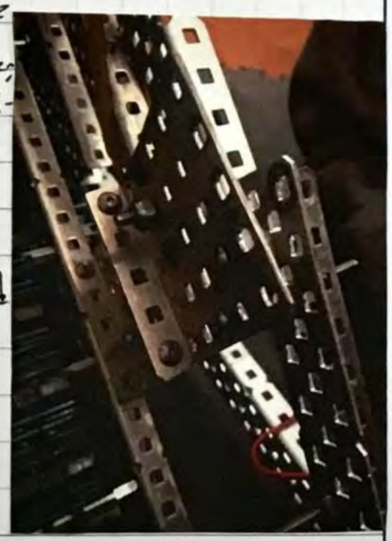


to this:



thinking that the second picture would cause the conveyor to slope downward instead of upward. However, for elastic to work, the two attachment points must come together indicating that the rubber bands are coming together. However, although the configuration in the second picture techically pushes the two bars together, we put screws in the ~~parts~~ spots where the elastic would be attached to, and saw them separate as the bar lifted. That means that the tension would actually go against the bar as it raised, so we decided to change the intake mount instead. We reasoned that the elastic makes the lift perfectly parallel, so if the angle is wrong when the lift is perfect, the ~~[illegible]~~ angle itself is imperfect. Therefore, we played around with the intake attachments until we made an angle that was flat enough for us.

However, we noticed that the roller touched the ground at its new orientation. While discussing adding a bigger stop (black spacers), we noticed that we depended on the perpendicular edge of the L-bar to hit the stop and keep the angle. However, one side had a worn in section where it hit the standoff we used as the stop. Therefore, we rotated the L-bar so that the flat surface of the L-bar, which would not wear down, would hit the stop as shown to the right. With the new orientation, we discovered that the roller no longer touched the ground.



We then tried the drive train out. We noted that the front two mecanum wheels clicked because there was not enough tension on the

SIGNATURE

DATE ~~[illegible]~~ 2/15/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

chain. Therefore, we added a tensioner in the form of a spacer screwed to the drive train to the chain. The mecanum wheels stopped clicking, but the drivetrain would not strafe well, because the robot would rock alot. We studied the drive carefully, and realized that the wheels in front would actually bend upwards because the 1x25 connection was not strong enough. We therefore made a stronger second connection by attaching a rail spanning both drive c-channels screwed to the linear slide rack as shown to the right. However even with the strong connection, the robot still didn't strafe well. No matter what, the front wheel is a very small amount of space away from the mount which gives the robot stability, but it can still rock a miniscule amount. The rocking problem becomes exasperbated on the mats, which has some give. Unfortunately, we don't have any spare four inch omni-wheels, which would solve the rocking problem. Instead, we added washers to the rail/linear slide rack connection above so that the wheel would actually bend forwards. This made the wheel go a little lower which helps the robot strafe better, but it still does not work as well as we want it.

Finally, we added string to the high goal scorer. First, we attached string to the support bar off the 6-bar. We then raised the 6 bar to the top, and tied the string to the scorer so that it would be tightened when the 6-bar is up. We also added metal to the back of the high goal scorer so that sacks would not fall off.

Continued to page

SIGNATURE

DATE 2/15/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

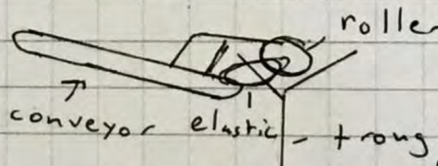
Lessons from South Brunswick

Today, we went to the South Brunswick competition, where our robot performed very well. We concentrated on getting the neutral gold sack during driver control and scoring it, then filling up the trough and descoring/rescoring. We ended up allying with the first seeded robot, but lost in the ~~second~~ semi-finals when our captain (3815A) and our robot failed in two consecutive matches. However, we learned several lessons about the competition from the event which are:

- Not many robots go under the troughs, so the main defensive actions occur at the trough.
- The high goal is very important because sacks scored there are virtually descorable
- A good scouting strategy is very important.

To counter the first lesson, we would like to gear the motors for speed so that our drivetrain would have a 1.67:1 ratio. That way, when we see a robot about to descore our trough, we can quickly reach and defend our trough. However, we don't believe our robot could be reliably geared for speed since it is very heavy. Therefore, we will instead counter it with our descoring.

Right now, when we try to descore into our own intake, we can get 3 or 4 out of the top ~~of~~ of a well filled trough. We cannot however, reach the bottom of a well filled trough to descoring because our conveyor angle is too steep. The only way the round roller can intake into our conveyor belt is by exerting pressure down on the sacks and spinning inwards. The pressure from the intake rollers comes from elastic. However, the only way for our roller to exert pressure on the trough would be by orientating it like below:



Continued to page

SIGNATURE [signature]

DATE 2/16/13

DISCLOSED TO AND UNDERSTOOD BY

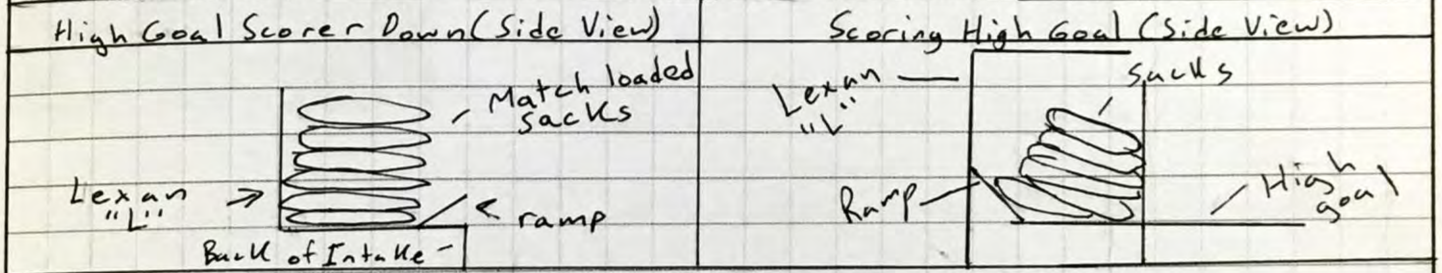
DATE

Continued from page

Changes after South Brunswick

However, at the current angle, when ever we try to orient it like the diagram, the intake gets stuck inside the trough and we cannot bring it out. Therefore, we would like to steepen the angle by off-setting the 6 bar so that the robot can outtake faster, and descore without getting stuck on the trough. We will also make the drivetrain perform better by replacing the two 2.5" omni's up front with 4" ones, solving the stability issues of the drive.

In order to counter the second lesson, we will improve our high goal scorer. The main problems with our high goal scorer were that sacks could easily fall off, and it wasn't accurate. To ensure that sacks don't fall out, we will create a large lexan l with 5"x5" pieces of lexan so that sacks cannot fall out. to ensure accuracy, we will add a ramp, so that sacks will be forced to fall forward. The new scorer will look like this:



Finally, to address the third lesson, we will download the Vex Scouting Manager App, which works for Apple IOS products. The APP lets us list team names, take pictures of the team, and record specefic performance metrics such as autonomous scores, speed and driver ability. Our favorite part of the app however is the "In reference to my robot" where they have on/off switches for "strong opponent" and "alliance." This way, we can quickly know when we're about to face a difficult opponent and have a list of teams we may want to ~~ma~~ ally with. We will get some information from talking to teams at the in pits, and taking pictures. However, our main scouting will be during matches, where a robot's true performance is shown.

Continued to page

SIGNATURE

DATE 2/16/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

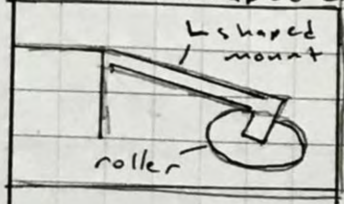
PROPRIETARY INFORMATION

Continued from page

Making Improvements

Today, we started to make the improvements menthioned in the previous page. We first moved the attachment points of the intake around to create the offset. Once that was done, we moved the holes up in order to accomodate a 4" omni-wheel at the front that would bring additional support to the drive train.

We also tried to improve the roller mount. At it's old orientation, the roller simply sat on top of sacks, and it's spinning motion brought sacks in. We changed the straight mount into an L-shaped one as shown below so that the weight of the roller would be going straight towards the conveyor belt instead of the ground.



Continued to page

SIGNATURE

DATE 2/18/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

High Goal Scorer

Today, we assembled the high goal scorer by attaching a 5 inch by 5 inch sheet of plexiglass to the c-channel that comprised it before, and added a plate with another sheet of plexiglass attached. This way, sacks have plenty of space to rest on.

We then mounted the hinge onto the high goal scorer.

However, this time we mounted it in the middle of the c-channel instead of at the end. This is to increase the moment arm so that the robot will require less force to take the high goal scorer over.

Continued to page

SIGNATURE

DATE 2/19/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Tuning the Intake

Today, we tested the intake to see how well it could pick up individual sacks and the stack of 5. We noticed that the conveyor-belt would drive over sacks many times, so we took the belt off, and moved all of the axles and supports for the treads one hole down. This way, sacks will be forced to go into the intake instead of under it.

We then tested the intake and found it worked better, but we still have to stop at the 5 sack stack for a bit to pick it up. Our goal is to make a robot that can intake the stack without stopping the robot. Therefore, we tried to make the intake come from a steeper angle so that it would push sacks into the conveyor belt. We first tried to do this by adding a bar over the top of the intake, and hinges for the mount to pivot on, but we quickly realized that we couldnt make the hinges wide enough to attach the intake to.

Instead, we decided to make the roller pivot from the sides instead of over top. Therefore, we added two c-channels to the module we had before, as shown to the right so that the roller could still come from above. We tested it, and found that the two sides moved apart too much, so we add a rail across to keep the sides even. We tested it again, and found that the robot could quickly intake the 5-stack while moving forward. However, we must still find a way to make it fit with the size limits.

Continued to page

SIGNATURE

DATE 2/20/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page

Descoring

Today, we took the new robot and tested it's descoring ability. We found that although it could pick sacks up from the ground very well, the roller simply rolls on top of sacks while trying to descore. We therefore added elastic pulling the roller down to help put tension on the sacks, but even then it could only descore the top of a well filled trough. We decided that the offset actually made it harder to descore because sacks could easily fall off. Therefore, we undid the offset of the 6-bar, ensuring that the intake's angle would stay constant.

We then also realized that the intake would never fold within the size requirements, so we decided to redesign the intake mount again. We still want the mount to come from above, so we attached a c-channel to the pivot point, and then place a roller at the spot we wanted it. We then added metal until we attached the roller to the c-channel as shown to the right. We found that this orientation does not intake as well as the previous one, but it can descore a lot and flip to stay in the 18". However, at one point the robot tipped, and the plexiglass on the high goal scorer broke. The roller also drags on the ground. Tomorrow, we will replace the plexi-glass and add stand-offs under the first c-channel to act as a stop.

Continued to page

SIGNATURE

DATE 2/21/13

DISCLOSED TO AND UNDERSTOOD BY

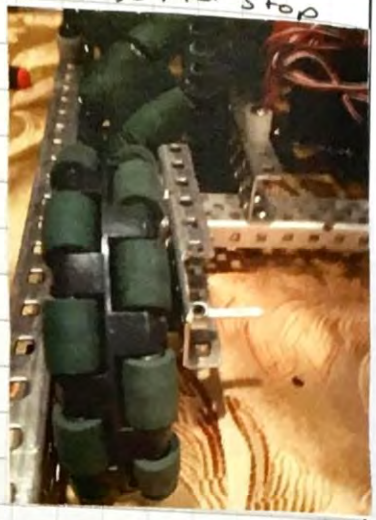
DATE

PROPRIETARY INFORMATION

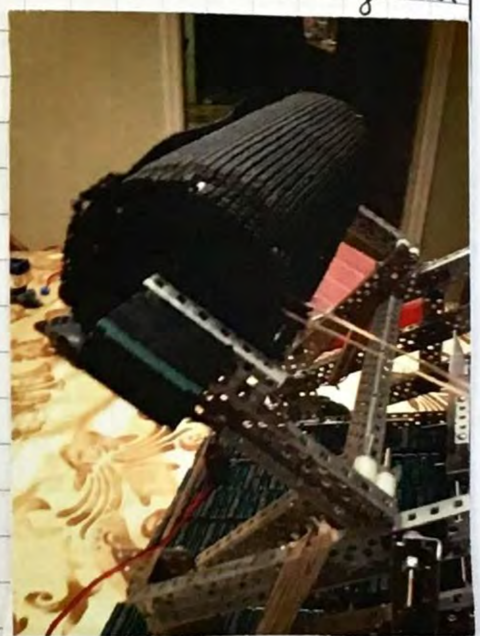
Continued from page

Perfecting it

Today, we added a new stop to the ~~intake~~ high goal scorer, and a better stop for the intake. We also added elastic to the rollers for tension. We then cut slots out of the front c-channel because it would interfere with the ramp before, and added a stop of ~~the~~ a spacer screwed to a c-channel as shown to the right. However, we found that the ~~integrated~~ shaft encoders, attached by stand-offs, can easily get loose, so we took off the stand-off's and mounted the encoder using screws.



We also added the rope to the high-goal scorer. However, this time we made it so that when the lift is all the way up, the hinge only goes up part way, making the high goal scorer be at an angle towards the trough, ensuring that the sacks would fall into the trough. We then created a hair-trigger start for the intake to flip down, by bringing it up and securing it in place with a rubber band. When the intake spins, the rubber band will go free, letting the rubber bands of the roller bring it down. We also created an autonomous as described in the next page.



Continued to page

SIGNATURE

DATE 2/22/13

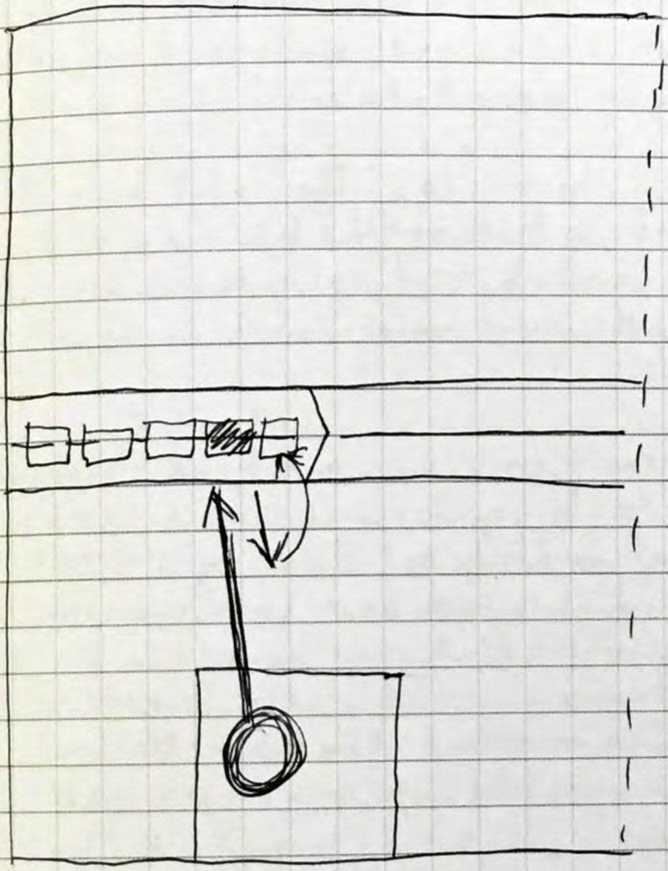
DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Programming

Today we created our first autonomous. We use the screen to select the side of the field (either right or left) and then further select the autonomous routine. For our left side autonomous routine, the robot goes for and attempts to intake the gold sack, along with the two sacks to its right and left. It then backs up, lifts, moves forward, scores, drives backward, and lowers the lift. The goal is for it do return to its starting tile after scoring.



To accomplish these tasks we employed the use of the potentiometer for lifting, and the two shaft encoders on the front wheels for driving. Shaft encoders allow for more accuracy when traveling distances, and allows for position to be absolute. This means the speed of the wheels can be changed without having to change timings.

Continued to page

SIGNATURE [signature]

DATE 2-22-2013

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Parting Words

After the last entry, 2616B went on to compete in, and win the New Jersey championship. Therefore qualifying for worlds. Because of that, I stopped working on this notebook, but work on the robot continued. In fact, we built a completely new robot with a pneumatic angle changing ramp, 17.5" wide intake and a 6-motor drivetrain. We took this robot to worlds, which should have done very well. However, we only did well, but I learned some important lessons from the experience that I would like to impart to you!

1. Perfect your design before going to Worlds: The robot was shipped 95% complete the week before worlds. We didn't finish working on it until our 8th match, and even then, we never got our autonomous working. Make sure your robot is absolutely perfect before shipping to worlds.

2. Practice Driving: As you can see from this notebook, we spent A LOT of time designing and building. Because of this, driving took a back seat. Sub-par robot with great driving > great robot with subpar driving. Have days where you just have practice matches with other club members so that everyone can drive at a worlds level. Instead of always striving for a better robot, take a break when you have a robot that works well and practice driving until you can control it to it's greatest potential.

3. Have several great autonomouses: While having an autonomous is not necessary to win, it is essential if you want to get picked during worlds since most robots will have great autonomous programs. Additionally, have several working programs so that you can complement every alliance partner's autonomous.

Above are some of the things I learned during World's. Sorry for being cliché, but above all, make sure you have fun! Enjoying what you do will ensure your team

Continued to page 91

SIGNATURE

DATE 5/25/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION

Continued from page 90

Parting Words Cont

always works well together. However, make sure you also ~~do~~ do the less fun things pertaining to robotics i.e. fundraiser's and this, the engineering notebook. Yes it may seem like a drag, but if you want to go to worlds, making a great engineering notebook as well as a great robot is the best way to do so. That is why I wanted to give this book as a model for you to use. However, don't try to match this notebook, this notebook is a lie. Make a notebook filled with CAD drawings, physics equations, diagrams and daily logs actually written the day events happen. The competition is only going to get tougher, you must make sure you don't get left behind.

(Insert amazing transition here) Anyway, robotics has been the highlight of my high school career. Every tuesday and thursday, I came excited to work on my own robot and help you newbies build something that moves. I sincerily hope that my work in the club has helped you in some way. I enjoy being an ass-hole, so if I ever hurt any of you with my comments, please know they were said facetiously (or you deserved it) and I apologize profusely for any pain I have caused you. Leading you guys has certainly been an awesome experience, and I've got to say, the future is looking bright. Oh yeah, make sure you guys frequent Vex forum (consider this tip #4). You can participate in interesting discussions with other elite robotics kids from around the world, see interesting robots and concepts other people are making, and help get our clubs name out by interacting with people. However, don't copy people's designs, make them better by putting ~~them~~ your own spin on it and testing different configurations. I'm sorry for that long digression, this is a pretty stream-of-thought goodbye note. Anyway, you guys have helped make my last year in robotics a great one, and for better or for worse, I will make sure to drop buy once in a while to make sure everything is structurally sound because the Cherry Hill East Robotics Club will no longer accept any sketchy shit! But in conclusion, thank you all so much for a great year in robotics! Please remember me in the future as you dominate competitions in Vex and more.

Continued to page

SIGNATURE

DATE 5/25/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

Continued from page

Instructions

Throw this book out or disrespect it in anyway, and I will hunt you down.

Continued to page

SIGNATURE

DATE 5/25/13

DISCLOSED TO AND UNDERSTOOD BY

DATE

PROPRIETARY INFORMATION