About Us

Luke Fitzgerald, Kenny Chamberlain, Andrew Kim, Ethan Behr, and Myles Peterson can all associate themselves with FTC team "The Green Mountain Gears", team number 9721. We are located in South Burlington Vermont. We have done Jr. FLL, FLL, and this is our third year of FTC.

Luke Fitzgerald has played piano for 8 years and is a Vermont Chess Champion, he has also played soccer and baseball nationally.

Speaking of people who play national sports, Myles has been playing tennis national for a very long time and is very talented at tennis and the drum kits.

Andrew plays bass, clarinet, piano, and ukulele, as well as being on the FHTMS spelling team, and the district band in 2016 and 2017.

Kenny is on the A team for Math Counts at FHTMS, and plays basketball and baseball, as well as clarinet.

Ethan swims for BTC every summer, and plays trumpet and jazz piano and has been for a very long time, he enjoys skiing, and plays baseball.

PK Fitzgerald is the coach of our team. He coaches Jr. FLL, FLL and FTC and he was a founding member of the 501.c.3 non-profit, Teams of Innovative Problem Solvers.

9/10/16

Kenny, Luke and Andrew
UVM FTC Launch
Watched the launch video, participated in discussion with other Vermont teams. Made some preliminary choices about robot design, such as cube, shooter.

10/30/16

Kenny and Luke

The new phones arrived.

We were informed that the competition would not be held at UVM, and that it was earlier than previous years.

We studied umbrellas for the endgame to help us figure out how to get the big ball on the top.

We studied the center of gravity and mass of objects and what they mean and are.

11/4/16

Luke, Kenny, Myles.

All of our parts were working and plenty.

12/20/16

Luke, Kenny, Ethan

We broke into groups and created the chassis, catapult, ramp, and sweeper.

We got registered to the tournament.

We decided on a “U” cube design at 16” by 16” by 16”. We thought this would give us a little wiggle room in the event that something needed more room than we planned.

The “U” shape would allow balls to enter the frame and it would create a left, right and back wing. We wanted to place the catapult mechanism on one side of the robot and the sweeper mechanism on the other side of the robot. We wanted to leave room in the back for a linear lift.

We wanted to use central drive wheels with two sets of omni wheels on both sides of the robot to balance the robot. We wanted a bumper to prevent the robot from getting stuck.

We decided on a basic frame that would be made from 80/20 extrusions, wood or PVC. We did not have enough tetrix channels to make the frame we wanted and those parts would be very expensive to purchase. We also might not receive them in time.

We experimented with wood and pic frames. We used a miter saw to cut the wood to size. We started with 16” pieces and 14” pieces. We initially added then using bookend joints, but the wood split and was hard to hold together. We also used metal “L” connectors to hold everything together but the joints had weak sides.

12/28/16

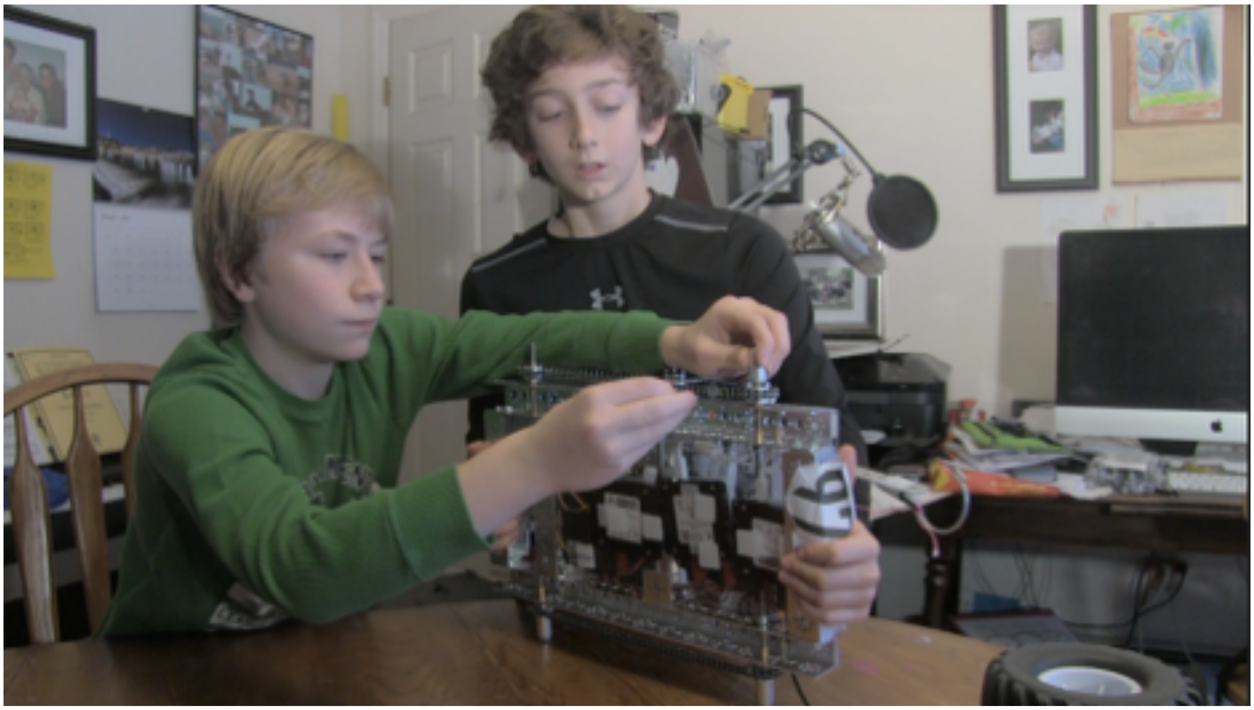
https://youtu.be/pIImPsyQz9A?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

12/29/16

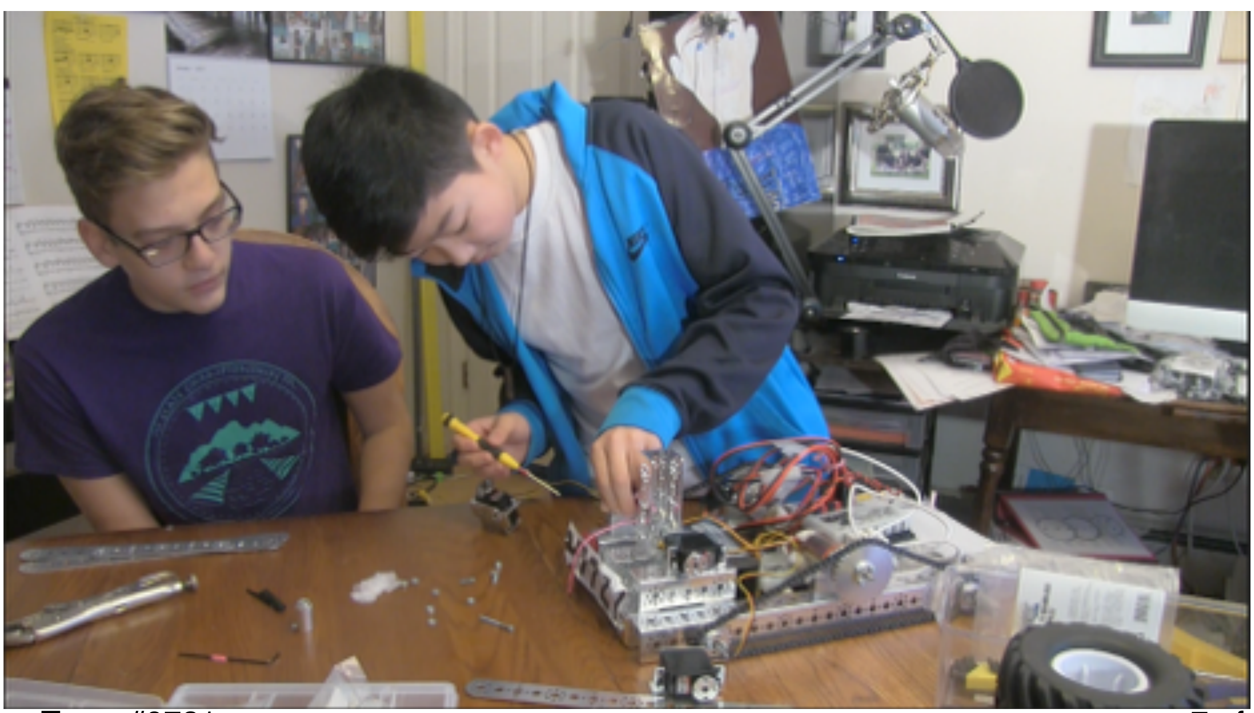
1/1/17

We did the robot dissection today of our old robot.

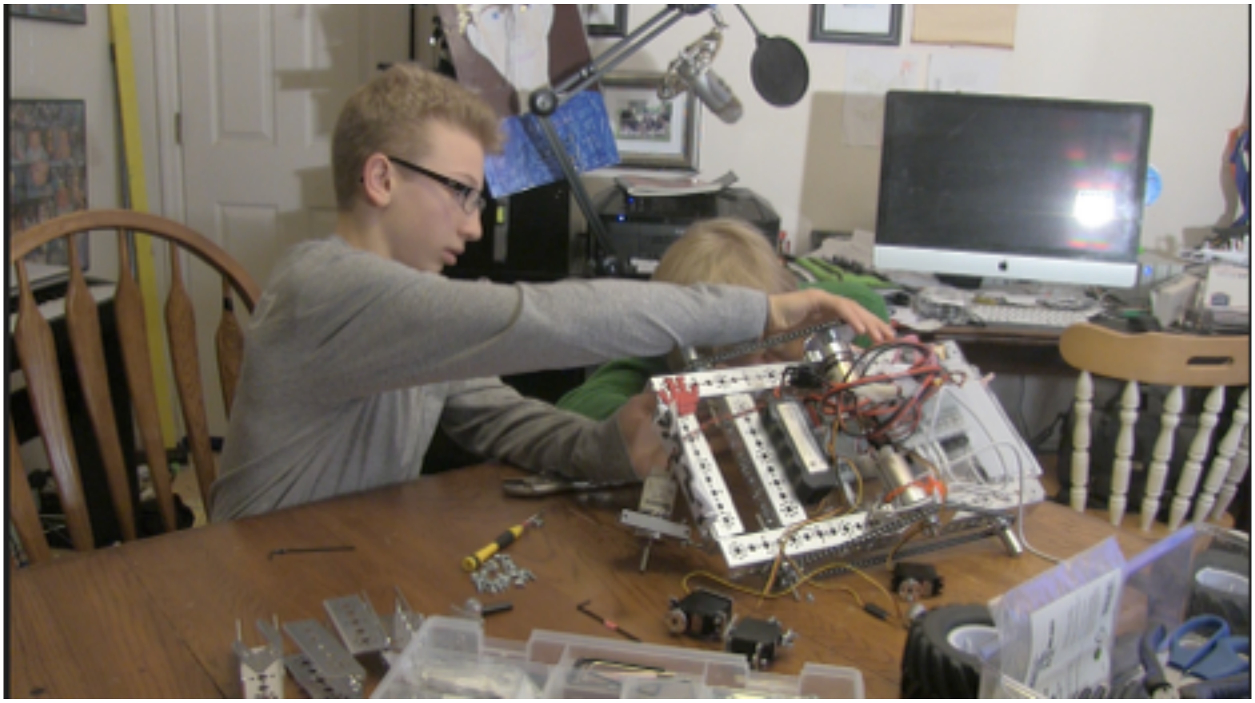
Luke and Kenny are taking apart the chassis.



Andrew and Ethan are taking apart the robot arm.



Kenny and Myles are taking apart the electronics, which was placed between plastic panels.



1/13/17

We tried 45 degree angles. We hoped this would eliminate the need for the "L" connectors. However, the wood and it still split. It appeared that the wood was too small relative to the size of the screws.

We built a pvc frame. It went together very quickly because PVC makes easy to use connectors. We had difficulty mounting the axles to the frame. We tried to drill through the pipes, which was easy. However, we realized than the pipes did not align easily, which made the design a challenge. We thought that a drill press would make for better holes, but we did not have one.

We watched a number of videos on YouTube that had designs similar to ours. We were especially interested in the shooters, as we did not know how to shoot repeatedly.

FTC Robot like our design
https://www.youtube.com/watch?v=u5UNZ9mj5Dk

Cam Gear and Follower VEX
https://www.youtube.com/watch?v=lrbUxmNRFqY

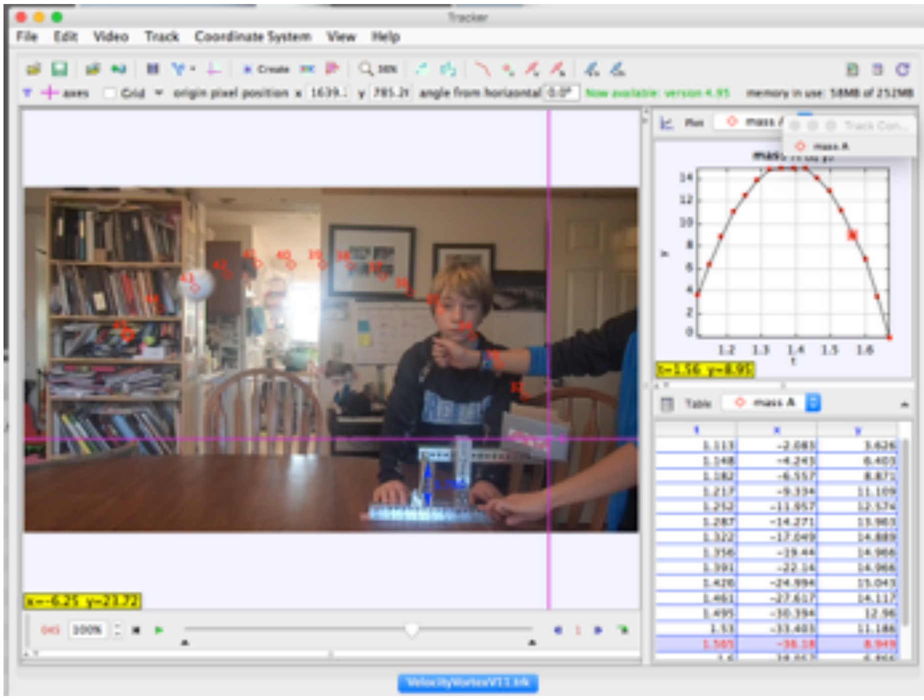
Nice Design with pitching machine style bot
https://www.youtube.com/watch?v=BiuFVnrBCPQ

After watching these videos, we ordered the advanced gear set from VEX robotics. It has an irregular cam gear that had a shape that would extend a string and then allow the string to

return to its based position.

1/15/17

We built a small catapult as a test of concept. We used it with three different strengths of springs. We took a video of each launch and then used TrackerPro to analyze the path of the ball in the air. We used the video to determine the maximum height of the ball to determine if it would be possible to get the ball into the hoop using this design.



After several designs, we determined that we needed to place a stop in the path of the catapult to cause the arm to stop and for the ball to fly away. This gave the ball much more height.

We exported the data from TrackerPro and into Numbers in order to do a polynomial regression on the data. We knew that the path of the ball would be an upside down parabola. The fitted trend line had an r^2 of .98, which was excellent.

First Test
https://youtu.be/zOJVZBOgnLc?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Second test
https://youtu.be/u3AFA8qs1Ic?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Catapult test 3
https://youtu.be/n3tiBRp2zVE?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Final test
https://youtu.be/L8Wj1v5qsGA?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

1/21/17

Luke, Kenny, Andrew, Myles, Ethan

We started of by stripping down a $4 2x4 into three rods of 1x1. We then cut the rods down to size with a miter saw, and started to connect the pieces of wood, that would hopefully become the frame.

Initially we were going straight into the grain of the wood for our connections. This resulted in cracking of wood and a unstable design. So the team turned to the Kreg jig which does not go straight through the grain of the wood. With only one screw, this resulted in a very stable sturdy design.

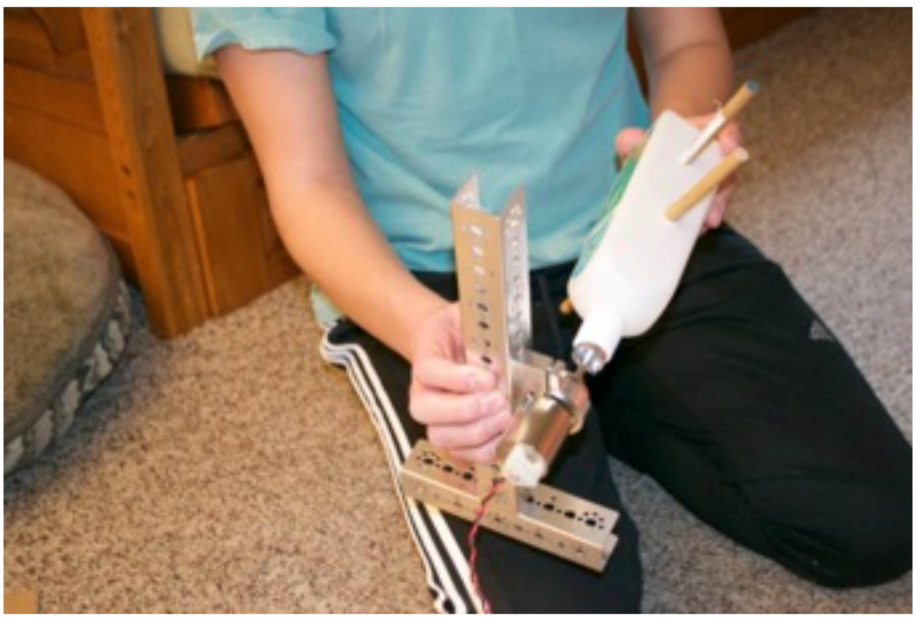
1/27/17

Luke, Kenny, Myles, Ethan, Andrew

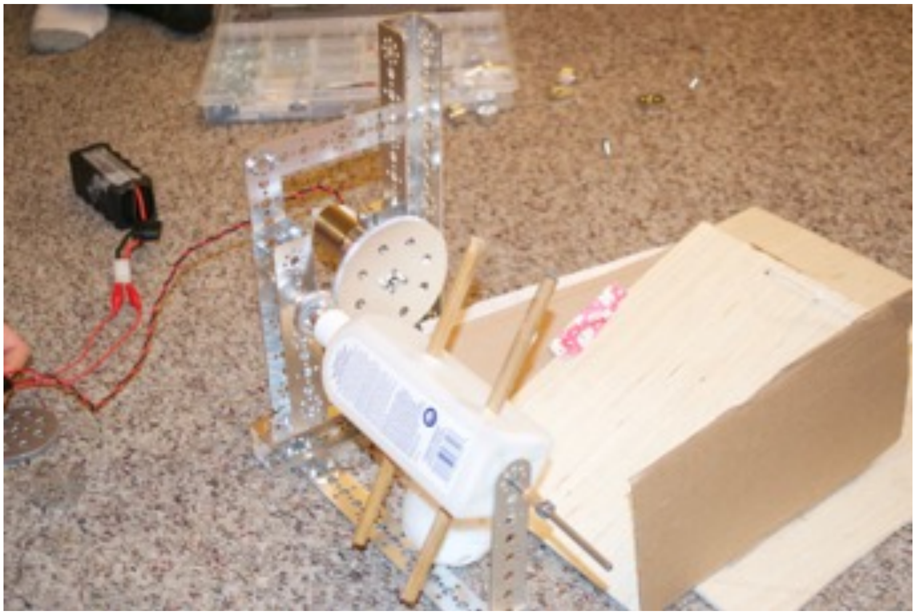
We again broke into little groups and Luke worked in PTC.

The wood downs worked well but the device was too slow to move the balls up the ramp consistently. There was also the possibility that the acetone bottle would unscrew itself and there was excessive wobbling.

Proof of Concept Wooden Dowel
https://youtu.be/JxX-BlzAv30?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY



The team decided they would need to gear-up the design.



The gear-up design was much faster and stronger. It needed to be balanced on the opposite side because the end swayed a lot and made the set-up unstable. We were also concerned about the impact of the wood on the ball it it hit at the wrong angle.

This is a video of the geared-up design.

https://youtu.be/r97rr8VZXQs?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

1/29/17

Luke, Kenny, Myles, Ethan, Andrew

Luke and Kenny worked on the chassis

Luke and Kenny mounted the motors and omni wheels. They did a preliminary design with 2 drive wheels and two omni wheels. The motor and the wheels were mounted to tetra parts, which were zip tied to the frame.

The team started the programming with the POV mode from the example. The design was the most simple, but it was hard to control because the center of turning was based on the drive wheels.

https://youtu.be/atmcZurBot0?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

The team compared driving the robot with 6 wheels, with the drive wheels in the center of the robot, which worked much better.

https://youtu.be/wh9Qwy89dVQ?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Andrew, Myles and Ethan worked on the geared-up sweeper

The team started off by using dowels through the acetone bottle but the problem was that if the ball got caught at a bad angle, it would jam everything up, so the team tested the sweeper with several different materials, including sponges, air hose and fuel hose. The sponge worked really well when attached with duct tape. The sponges also prevented jams from occurring, so the team went with the sponge.

Sweeper with Sponge Test
https://youtu.be/6piMxTJR6Nk?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Second Test of Sweeper with Sponge
https://youtu.be/u9xwGG_twXk?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

2/01/17

Luke

Luke Finished the PTC chassis design which uses real dimensions, parts and location. In doing this he made 3 sub assemblies, a frame, a drive motor, and an omni-wheel. Then when all 3 were complete he made one big assembly of all three sub assemblies, creating the robot's full chassis. Initially Luke thought he was going to have to make 5 sub assemblies with a right and left drive motor, as well as a right and left omni-wheel and the frame. This did not end up being the case.

02-02-17

This was the first prototype if the catapult, it was created by Ethan and Andrew. We took a lot of our ideas from this first prototype.

This video shows the preliminary test of the catapult with the CVex gear for repeated launches.

https://youtu.be/9LWeDv4qygU?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

This is Andrew and Myles revising and improving the the catapult design.

This is a geared up version of the sweeper.

This is Ethan trying to use new materials for the sweeper. The acetone bottle wobbled a lot when in operation because of the center of mass, which was far from the turning point. The acetone bottle was then balanced with a post on the opposite side of the sweeper, which made the design more complicated. Proof of Concept testing the acetone bottle balanced on both sides is here:

https://youtu.be/r97rr8VZXQs?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

We were also concerned about the bottle jamming, which is shown here:
https://youtu.be/PyeIrOIsf58?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

The bottle also limited the ways materials could be attached to the sweeper because the bottle was narrow. The bottle also had the risk of unscrewing if the ball got jammed. This is a demonstration of the bottle unscrewing itself

https://youtu.be/JxX-BlzAv30?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Ethan is attempting to mount a hose to the axle collar using a hose clamp. The plastic hose had too much memory to be useful. We attempted to stretch it out using a wood cylinder but the plastic retained its shape.

This Myles and Ethan attaching a piece of wood to the axle collar using small wood screws.

Proof of Concept Wooden Axle
https://youtu.be/nvd80HHdBj0?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

This video demonstrates that the wooden axle did not wobble as much as the acetone bottle.

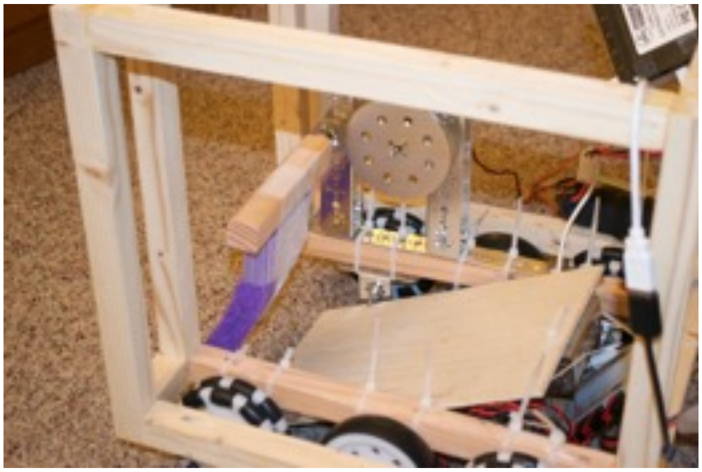
This photo shows Ethan and Myles placing the sweeper inside the chassis.

This shows the mounted sweeper test with a plastic wife ball.
https://youtu.be/RhOxpPeY_Ns?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

This shows driving with the ramp installed. There was an initial problem that had to be corrected. This our first ramp setup. It was a FAILURE!!!!!!!

https://youtu.be/X2zks2mpm8E?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

02/04/17



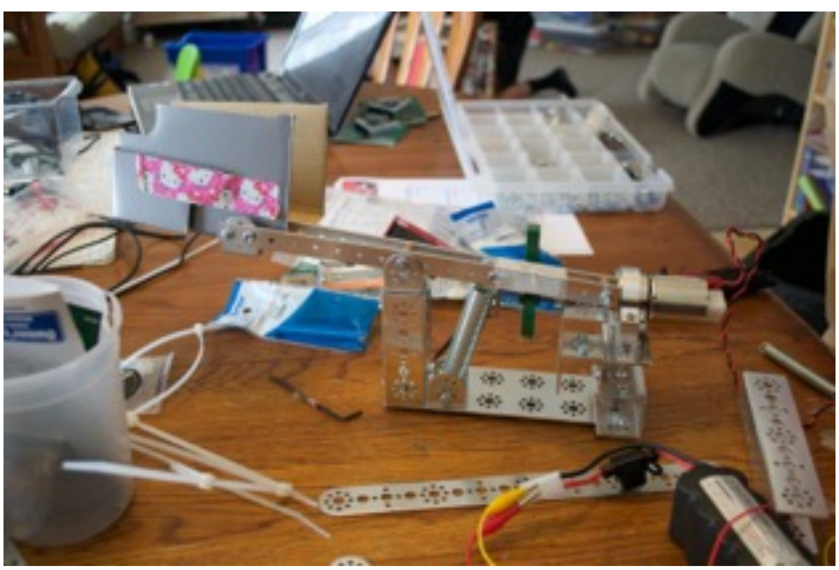
Luke and Kenny worked on using the sweeper and ramp.

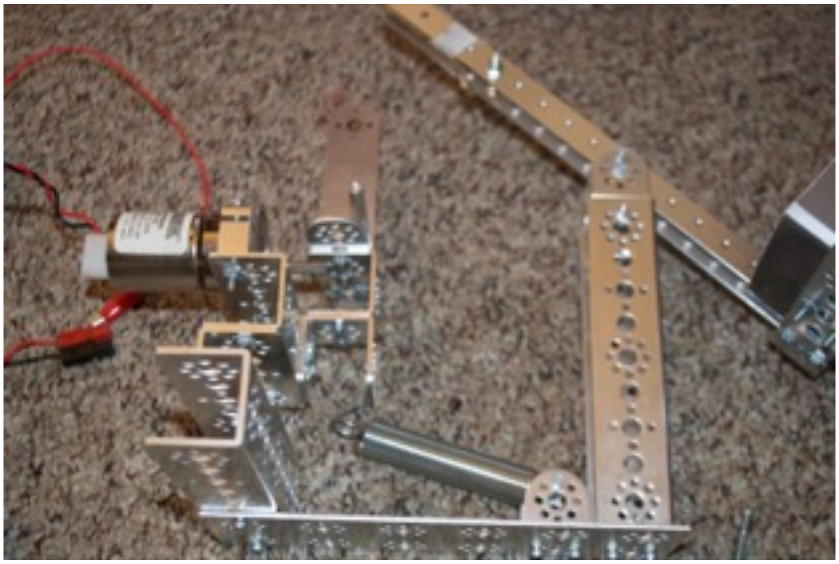
Based on the first installation, the sweeper needed to be lowered.

Luke and Kenny also worked on programming the robot for the sweeper.

This shows the sweeper working with the modified ramp and while driving.
https://youtu.be/vRpmYyQEBas?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Ethan and Andrew worked on the trigger mechanism for the catapult. The trigger mechanism was mounted to the catapult assembly.





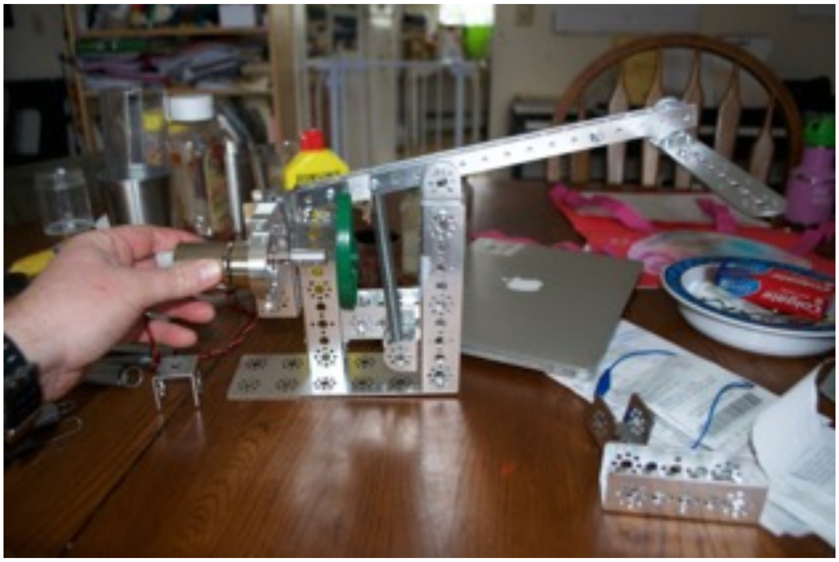
Proof of Concept “trigger”
https://youtu.be/eHqIRsrNcgQ?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Ethan Testing Based #3
https://youtu.be/C4Qjp6CxdJo?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Lateral Movement (blown fuse)
https://youtu.be/6mQA6q8F91Y?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Lateral Movement Vid.2 (slow motion, manual turning)
https://youtu.be/4pICmz3IeWc?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Lateral Movement Vid. 3
https://youtu.be/0_XcoUOXhsQ?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY



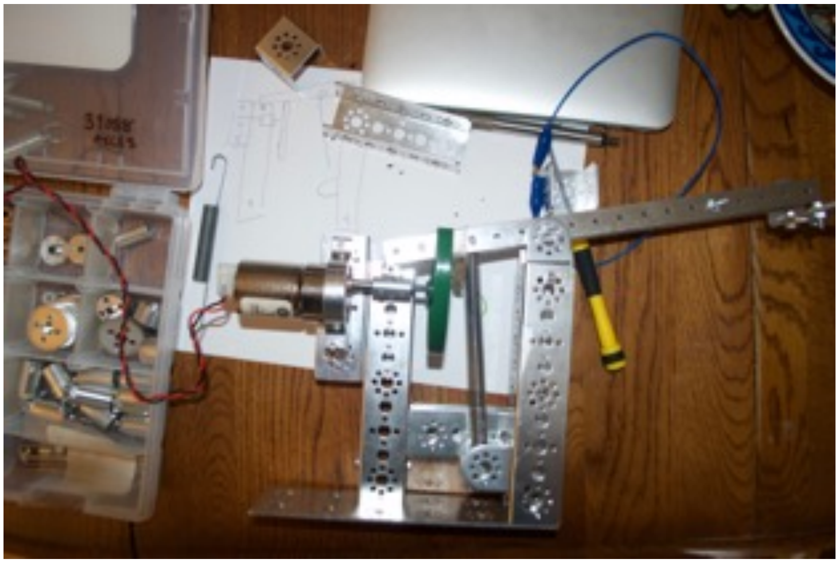
The assembly was moved onto a plate and the position of the events were changed.

The straight alignment placed the gear too far away from the lever arm so the posts had to be slightly offset.

During testing, a fuse broke in the batter power supply.

During the afternoon session, the breaker was replaced and there was more testing with the catapult.

02/05/17



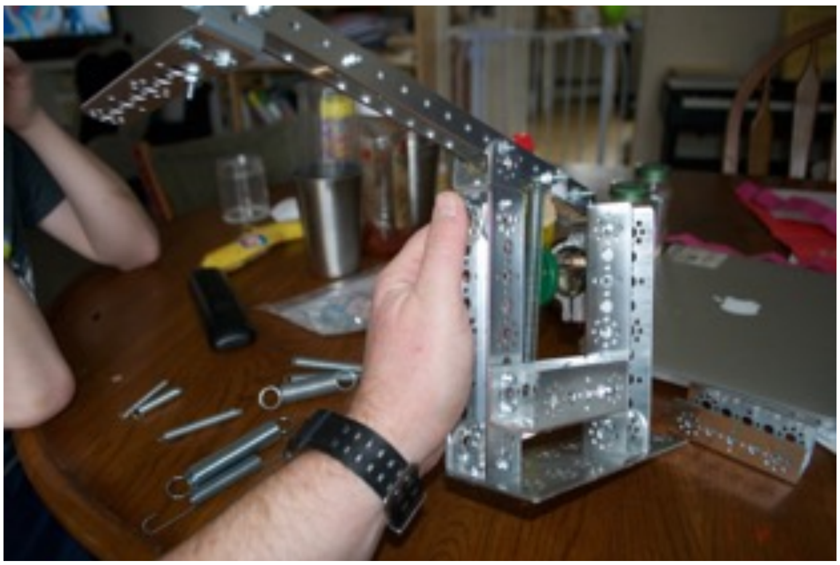
Luke and Kenny worked on refining the catapult. At first, they evaluated a variety of springs to make a selection as the spring that would work best for their robot.

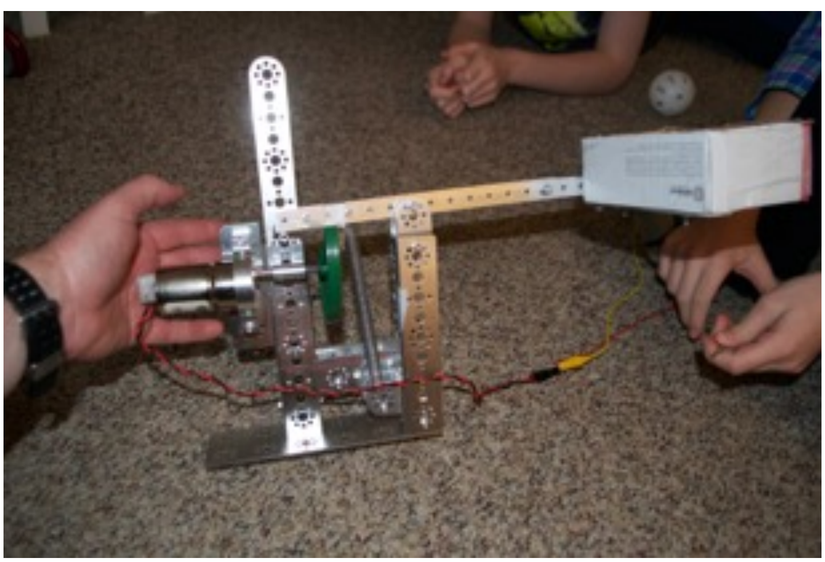
A new spring was selected and tested. in the initial test, the catapult did not go high enough.

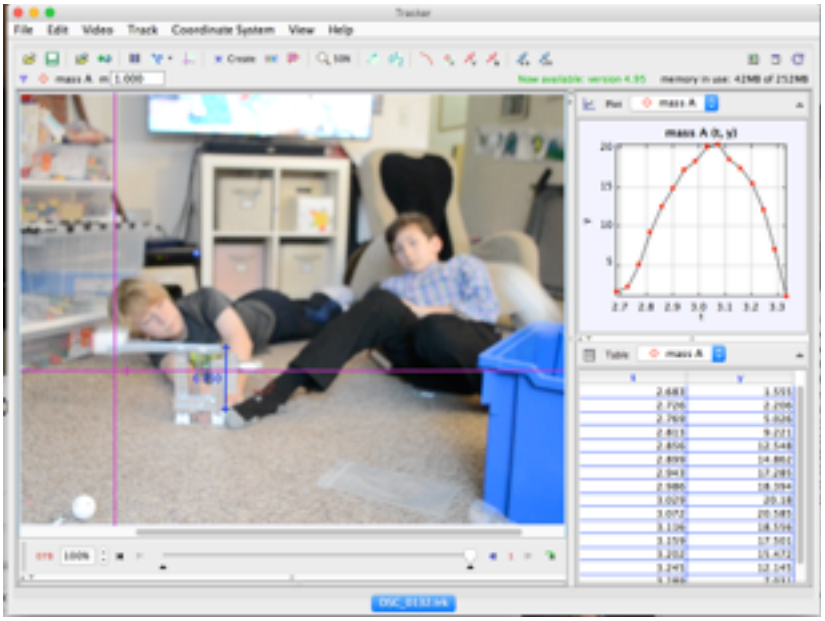
An adjustment was made to move the motor to close the gap in the assembly so that the lever arm would make better contact.

The device was tested using video analysis and trackerPro. The analysis determined that the catapult was firing 20 inches high, which was not high enough.

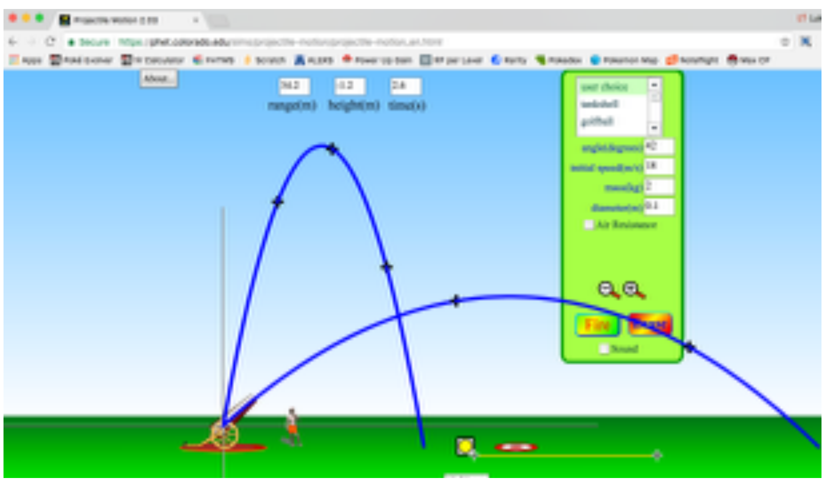
Luke and Kenny observed some projectiles using PHET's projectile game and decided to change the initial angle, so that the ball would go more vertical instead of more horizontal. This was done by lifting the placement of the stopper so that the lever arm stopped at an able that was close to parallel to the base plate.







Luke and Kenny tested the video and determined that the ball reached a height of 34”. This was considered high enough, provided the entire assembly can be mounted relatively high off of the floor.



After the tracker pro analysis was completed, Luke and Kenny set-out to mount the catapult to the frame. The catapult was less than 18” long but it would not fit inside the frame and operate with the back top cross bar.

An adjustment was made to change the initial angle of the launcher.

They tweaked the

Preliminary Adjustment to GAP (before angle adjustment) Version 1

https://youtu.be/PXAma8tOFn0?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Preliminary Adjustment to GAP (before angle adjustment) Version 2
https://youtu.be/q-zW7aym4AU?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Mount/Gear Adjustment for GAP
https://youtu.be/CUztZTHI20c?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Prior to Adjusting Launch Angle
https://youtu.be/3LpuiCZbSWU?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Preliminary Tests Final Base Design
https://youtu.be/PXAma8tOFn0?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

Final Test Pre-Mount Catapult
https://youtu.be/P2pGb5e8dy0?list=PLD56-Vhdt_JFsP0WbekpcMi053fmTTybY

2/7/17

Luke installed optical encoder onto motor so that the motor could be operated for exactly 1 rotation or 1440 clicks of the encoder.

It took multiple tries to get the encoder to work properly. The sample encoder program used functions to call the encoder behaviors of the dcmotor object, which made it harder to copy and paste into our program.

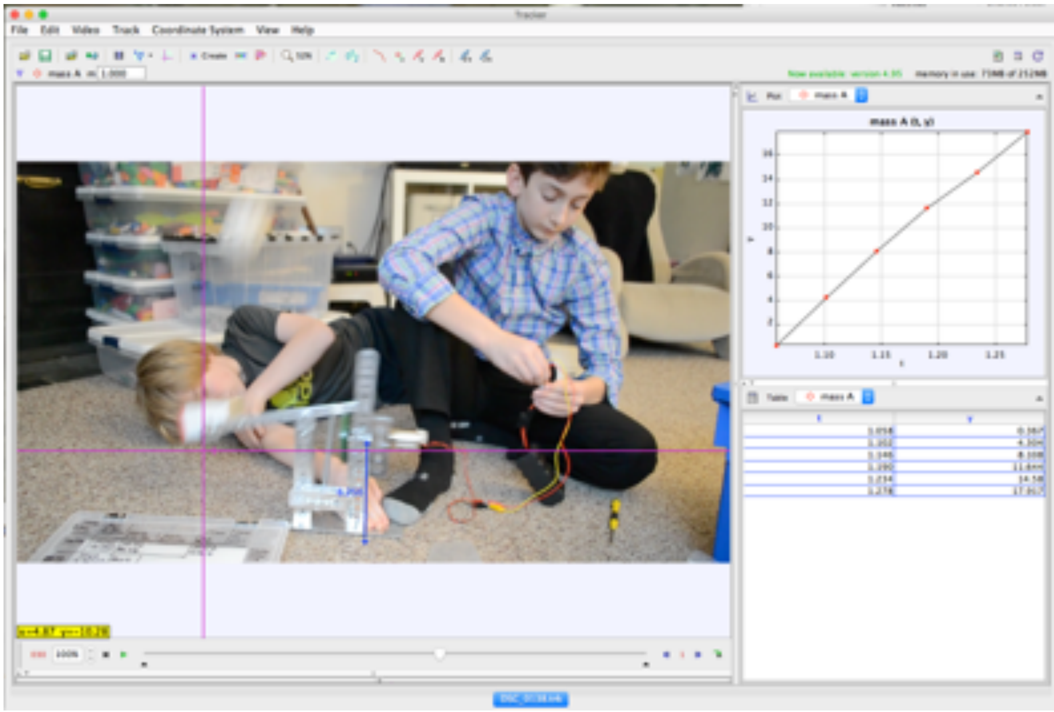
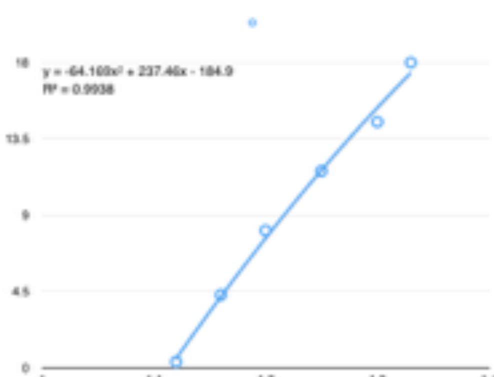


Table 1

1.1261	0.3670			
1.1678	4.3040			
1.2095	8.1075			
1.2513	11.6441			
1.2930	14.5802			
1.3347	17.9166			
	t	y		
	1.12	0.36		
	1.16	4.3		
	1.2	8.1		
	1.25	11.6		
	1.3	14.5		
	1.33	18		



Luke copied and pasted the information that seemed important.

```
if(gamepad1.x)
   //catapultMotor.setMode(DcMotor.RunMode.STOP_AND_RESET_ENCODER);
   catapultTarget = catapultMotor.getCurrentPosition() + 1440;
   catapultMotor.setTargetPosition(catapultTarget);
   catapultMotor.setPower(100);
   catapultMotor.setMode(DcMotor.RunMode.RUN_TO_POSITION);
   //catapultMotor.setMode(DcMotor.RunMode.RUN_USING_ENCODER);
   //catapultMotor.setMode(DcMotor.RunMode.STOP_AND_RESET_ENCODER);

if(gamepad1.b) catapultMotor.setMode(DcMotor.RunMode.STOP_AND_RESET_ENCODER);
   catapultMotor.setPower(0);
```

It took some time to learn that you can only run (1) dcmotor mode at a time. Luke research the different modes to learn that the run to position was the mode that was needed to get the motor to turn a single rotation.

Once the program was run, Luke could see that the motor turned slowly. It appeared to result from the fact that the encoder was monitoring the movement, which slowed it down.

2/8/17

Luke worked on the encoder and demoed it with the catapult. He noticed that the encoder program did not work as expected. When the "x" button was pressed, the gear turned more than expected.

Luke attempted to correct the mistakes and discovered that the encoder was running in the wrong direction.

He determined that the encoder was attempted to reset from the previous run. He used the reset command, which worked to stop the motor from running in the wrong direction when it started.

Demo Using Encoder
https://youtu.be/RC2Hr3yKUCg

Demo-Encoder Moving in Wrong Direction (attempted to correct by switching direction)
https://youtu.be/DECIs3D_ksU

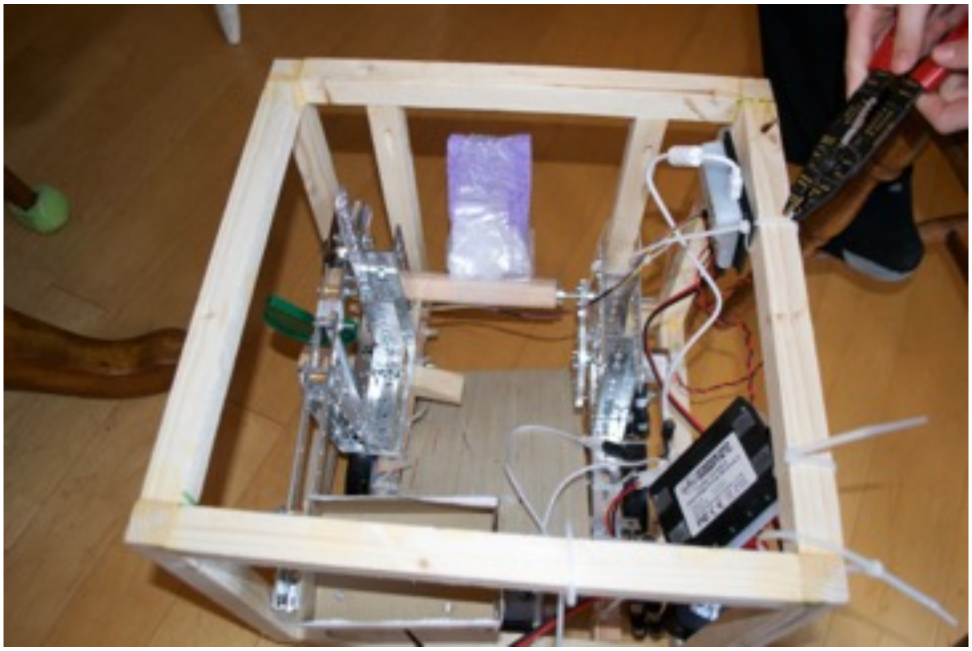
Demo Encoder Moving in Wrong Direction (attempted to correct by switching the sign of the tics)
https://youtu.be/WxH3u92Scz8

Successful Encoder Test
https://youtu.be/shwmANwgFNk

Once the motor was working correctly, Luke noticed that the motor was turning further than he thought it should turn. He estimated the excess turning and reduced the tics from 1440 to 1380.

With further testing, he discovered that the motor was still turning too much. He reduced the clicks to 1325 and repeated testing.

The encoder was still going to far so Luke attempted to run the motor until it returned to the original position after 8 button presses. He determined that if the total of 1440 in 8 turns would



be equivalent to an excess of 180 clicks per turn. He reduced the encoder distance from 1325 by 180.

At this point, Luke tested it again and realized that the motor turned whenever he held down the “x” button. This was a surprise. He expected the motor to turn (1) rotation for each press not that it would turn longer with a longer press. Once this realization was made, he hut the button the same and it appeared to work fine.

The next step was to mount the catapult to the frame. The initial effort revealed that the aluminum tetra flat needed to be cut to size. Luke did this using a hack saw.

Then, the flat needed to be mounted to the frame. Luke first tried a 3.5” piece of wood with wood screws. However, it was clear that this would not work without taking the entire catapult apart.

Luke removed the wooden cross bar and replaced it with a tetra channel. The tetra channel was easy to attach with wood screws and then the catapult was easy to attach to the channel.

After the initial installation, Luke realized that the catapult was too far backward. He moved it forward, but it still hit the back cross bar. He attempted to solve the problem by moving the hopper forward.

Demo-Mounted Catapult Forces Ball into Back Bar
https://youtu.be/_8k1XRT7EFw

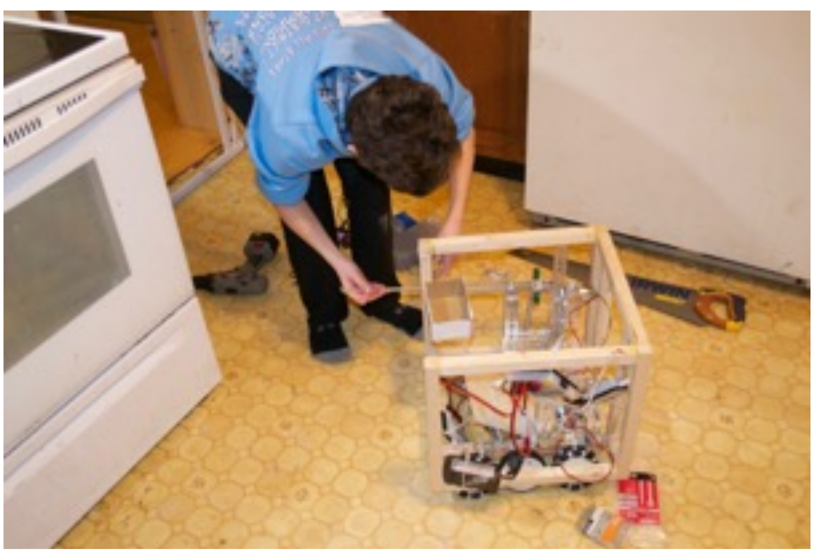
Demo-Hopper Slid Forward to Correct Back Bar Problem
https://youtu.be/6emk2Sp99Ic

He repeated the testing, but it still did not work. He moved the hopper forward again and it still did not work. Luke then decided to remove the back high cross bar. He did this by removing the Kreg Jig screws that held it in place. He then used a wood saw to cut the bar away.

Luke conducted some final tests of the design and it worked ok but did not aim well.

The team still needs to connect the catapult hopper to the ramp and the sweeper. The team may also elect to change the configuration file so that the left motors have a controller and the right motors have a controller instead of the driver motors with a controller and the accessory motors with a controller.

Demo-Test of Catapult with Back Bar Removed
https://youtu.be/vh9Zshunr9I



2/8/17

Luke completed the PTC Creo drawings for the parts and assemblies for the catapult. Luke also added a bill of materials for the assemblies.

The team met in the afternoon to finish work on the connection between the sweeper and the hopper.

Luke realized that if the catapult was placed at a more engaged position, the hopper would be lower, which would make it easier to load the hopper.

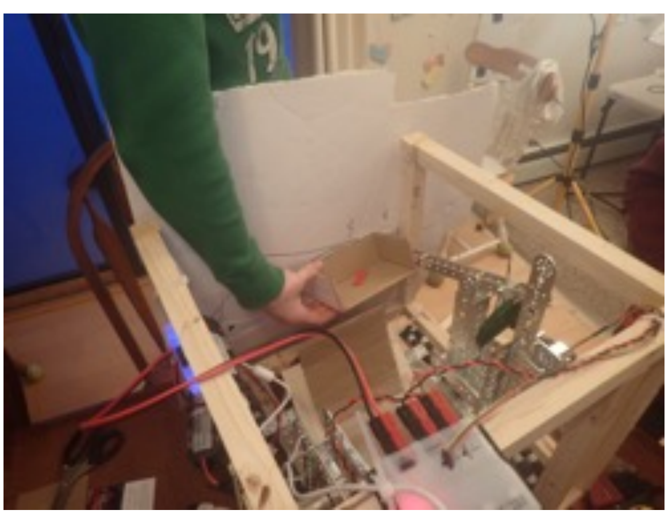
The team broke into several small groups to develop and test prototypes. Luke worked on a design that used foam board and a spider web of duct tape.

Ethan and Andrew used flexible aluminum duct.

Kenny and Myles used cardboard.

Luke worked on a web-design using duct tape. During testing, the wood bar ripped free from the screws. This was corrected using 3/4 " #4 screws to replace the 1/2" #4 screws. This approach was accepted because it was not clear how the web would deliver the ball to the hopper.

https://youtu.be/FnsSYxqVrKY



The next design was developed by Kenny and Myles. This design added cardboard to the ramp to guide the ball into the hopper. During the manual loaded (could not use the sweeper because the team had not repaired the sweeper with the longer screws yet). This proved that the cardboard approach might work.
https://youtu.be/9xbsL6VD6uw

This test revealed a problem with the design. This video shows how the ball can miss the hopper and get stuck in the back of the robot. If this happened in a competition, it would stop the scoring possibilities for the robot.

https://youtu.be/MEQx4UtGDJc

This test shows an improved side wall. The team also lowered the support for the ramp so that the angle is less vertical. The ball goes right into the hopper.
https://youtu.be/yxWTojXLkVM

This video shows the first test with the repaired sweeper. In this test, the ball bounces back off of the hopper. The team watched the video several times to determine that the hopper was in a position that would strike the ball.
https://youtu.be/qhIWNG6amn8

The team attempted to reduce the angle of the hopper by lowering it. The team also removed the front of the hopper to reduce the chances of it hitting the ball. The team did this by folding it under the box. The ball shot straight out of the back of the frame, above the hopper.
https://youtu.be/EoBJS05K7Jc

This video confirms the previous results that the sweeper appeared too powerful.
https://youtu.be/JOPfusQA0qk

The team reduced the power to 75%, but it was still too powerful.

The team then attempted to place a backboard to keep the ball from going over the back of the hopper. This worked to keep the ball inside the frame of the robot.

https://youtu.be/HHn8xN0YxkA

The team reduced the power again and got a little closer.
https://youtu.be/Vam2WKC_6MA

The team gets a little closer.
https://youtu.be/Hb8NblsVp3Q

The team gets very close
https://youtu.be/6oB9rMRWdbo

The team gets the ball into the hopper, but it bounces out.
https://youtu.be/nkPIH3lQ3PE

The team decides to build a front lip to hold the ball from ball away. The first test was not sufficient to hold onto the ball. The team decided to unfold the front of the box.

Finally, the team gets the ball into the hopper.
https://youtu.be/qLxGjmi-KDs

2/10/17

Luke re-wired robot and changed the configuration file so that each side of the robot had a motor controller instead of the drive system to a motor controller and the accessory motors to another controller. Luke hoped this would reduce the chances that the robot would snag a wire during operation and it made for a more organized robot.

Business plan draft was completed, converted to PDF, uploaded to website and printed.

Engineering Notebook was converted to PDF and published on website.

Engineering Notebook was completed, converted to PDF, uploaded to website and printed.