Build

N.E.R.D. BOTS! TEAM #14353

FIRST TECH CHALLENGE

FREIGHT FRENZY

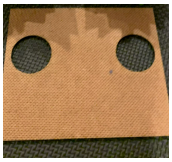
PRESENTED BY Raytheon Technologies

Task: Design an Intake	**Build**
Date: Sep-21-2021	Attendees: Neha, Sushanth
Time: 7:30-8:30 pm	Location: Online

We discussed which intake we should design and the advantages and disadvantages of each intake design. We decided to do the Clapper design. After we designed the scooper, we came up with another idea instead of having an arm on top of the scooper to secure the freight. We decided to have two panels on the side of the scooper to hold the freight in place. The scooper clapper design we came up with will be attached to an elevator design. We caded most of the design today. Sushanth will do the rest and we will talk about it again tomorrow.

CAD a design for a roller plate	**Build**
Date: Sep-23-2021	Attendees: Evie, Ryan
Time: 6:00-8:00pm	Location: In-person

We decided to test Evie's roller design. The design was two motors with gear shaped rollers at the end of them. The test was how much freight could the intake pick up in ten seconds. After seeing that they worked fairly well, we decided to make a plate to hold it still. However, when we did CAD it, the plate was made too small. After we found out the problem, we decided to make the plate wider so that the freight could go between the rollers.



Task: Design an Intake	**Build**
Date: Sep-23-2021	Attendees: Nandan, Vaman, Maddie
Time: 6:00-8:00 pm	Location: In person

Today we tried the idea of a claw. When we tried the design the claw wasn't good for accuracy. When we went for one cube or ball most of the time another one obstructed our claw. And if and when we got one it was hard to pick it up. Even if we picked it up when we were going back up the cube or ball fell out of the claw. And we finally gave up on this idea.

CAD a new design for an upper & lower roller plate	**Build**
Date: 25-Sep-2021	Attendees: Evie, Ryan
Time: 2:00-4:00pm	Location: In-person

Today we caded a new roller plate that was wider than the last. We added four small holes to the plate in hopes of securing the rollers by screwing them together. We ended up only using one plate. The problem was that all the holes were too small and tight, so we had to measure again and re-CAD. This time however we decided to make a lower and upper plate. While I am working on the plates, Evie is making a containment unit that the freight can go in.

Cad	**Build**
Date: Sep-26-2021	Attendees: Mahati, Zack, Ethan, Maddie
Time: 4pm-6pm	Location: In-person

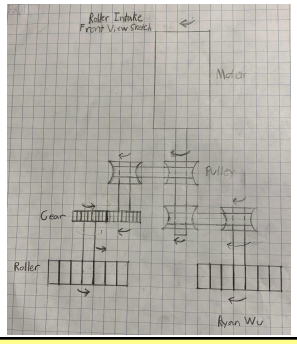
Today we made a template for the robot so we experimented with it as well as a cardboard arm for picking up freight. We need to finish the cardboard robot as we only finished half of it. We measured the robot and we figured out that the gap for the rollers wasn't big enough. So we have to fix that.

CAD Top plate and chassis	**Build**
Date: Sep-26-2021	Attendees: Nandan
Time: 4:00-6:00pm	Location: In-person

Nandan continued working on adding holes to the top plate, and he also worked on finishing the assembly for the chassis and drivetrain. He learned how to easily make holes in an assembly.

Print and test out a new design an upper & lower roller plate	**Build**
Date: Sep-26-2021	Attendees: Evie, Ryan
Time: 4:00-6:00pm	Location: In-person

We discussed a new design for the intake when we can only use one motor. We had to add gears and pulleys to make sure the two wheels spun in different directions to pull the items inwards. We also cut out the top and bottom plates and assembled them together to see if the width was correct. We figured out that we needed to make the wheels a little bit further apart.



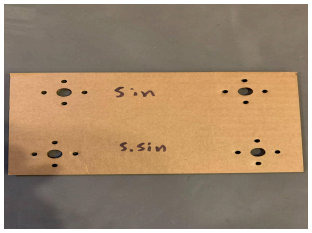
Task: Find Wheel for ducky disk	**Build**
Date: September-26 -2021	Attendees: Vaman, Zack

Time: 4:00-6:00pm	Location: In-person

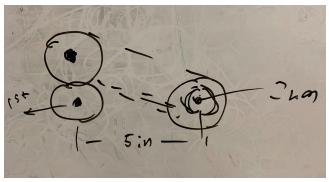
On Sunday we moved on to the ducky disk and worked on the wheel. When we tried multiple wheels we figured out that the smaller wheel was better. And we were going to place the ducks and figure out if where the duck was would make it faster. We finally thought to read the rules and know how to place it down.

CAD & test new lower plate & design a new one motor intake	**Build**
Date: Oct-2-2021	Attendees: Evie, Ryan
Time: 2:00-4:00pm	Location: In-person

Today we caded a new lower roller plate to find out a better distance between the two rollers in order to intake the freight. We caded two sets of holes to try out the best distance between the rollers. We laser cut & tried out the two distances, 5.5in & 5in. The results were that the 5.5in distance was too wide and the 5 in distance picked up the freight fairly smoothly, so we decided to use the 5in distance.



We also designed a new one motor intake. We decreased the number of pulleys from four to two. The new design was to have a pulley and a gear mounted on the same motor shaft.



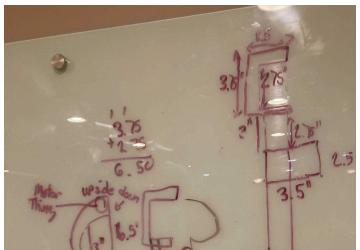
Design a way to move freight cargo from the robot to the shipping hubs	**Build**
Date: 2-oct-2021	Attendees: Maddie, Ethan, Mahati, Tahim
Time: 2:00-4:00pm	Location: In-person

https://files.slack.com/files-pri/TK2J5CPL5-F02G1Q2NXJB/img_2416.jpg

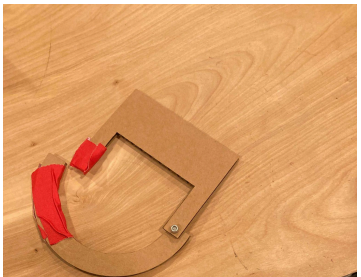
Task: finish the ducky disk	**Build**
Date: Oct-2-2021	Attendees: Zack, Vaman
Time: 2:00-4:00pm	Location: In-person

We tested the motor with different wheels and we found that the small wheel was the best one, so we created a place to store the motor securely. We settled for a box that was 7 by 7 by 7 inches. We added cardboard to the bottom to make it exactly tall enough.

Find a way to move Freight from inside The robot to shipping hubs.	**Build Build**
Date: Oct-2-2021	Attendeens: Maddie and Mahati
Time: 4:00-6:00pm	Location: In-person



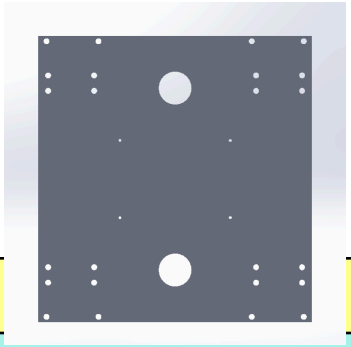
First thing we did was do a claw/chopstick pincher but the



swing open would take up too much space. So we Are now working on a lowering arm that would trap the cargo.

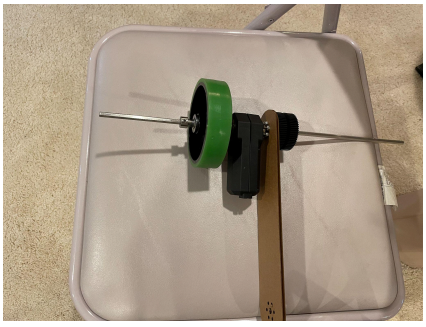
Task: work on chassis	**Build**
Date: Oct-3-2021	Attendees: Nandan, Tahim
Time:4-6pm	Location: In-person

Today, Nandan worked on making holes for the drive pods and making holes for the control hub. Tahim worked on making the side plates for the chassis. Had some trouble syncing everything to GRABCAD, and making sure we were on the same file. Nandan learned how to mirror things.



Task: Work on intake design	**Build**
Date: Oct-3-2021	Attendees: Neha, Sushanth
Time: 4-6pm	Location: In-person

We printed the arm for the intake, but realized we had the measurements wrong. We learned how to make all our parts turn black on Solidworks. WE also learned how to mirror shapes. After we printed the correct arm, we started to attach it to the gear and wheel.



Task: Assemble the one motor idea.	**Build**
Date: Oct-3-21	Attendees: Evie, Ryan
Time: 2:00-4:00pm	Location: In-person

We went ahead and started assembling the new one motor intake. We cut the 5 in board and attached the motor and gears onto it. When we were finished, we found out that one board wasn't stable enough. We then decided to add an additional plate for support. When we added an additional plate we also found that the bearings weren't secure, so we decided to try a new type of bearing.

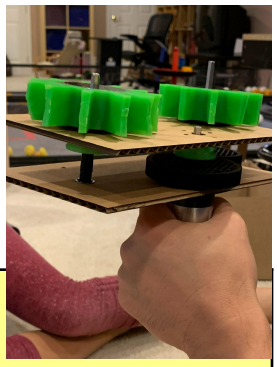
Date: Oc-3.-2021	Attendees: Zack, Vaman
Time: 6-8pm	Location: In-person

We designed a cap that was 3" by 3" with arms but the diameter of the hole was 2" so it could be a cap. We had to use many different designs before coming up with this design.

Task: Assemble the one motor idea.	**Build**
Date: Oct-3-21	Attendees: Evie, Ryan

Time: 2:00-4:00pm	Location: In-person

We decided to try the new type of bearing and assemble the one motor idea parts in CAD, instead of doing it in real life. While Evie was making a cad model of the wheel, I was putting all the pieces together and forming the model.



Task: Assemble the one motor idea in CAD (continued)	**Build**
Date: Oct-9-21	Attendees: Evie, Ryan
Time: 2:00-4:00pm	Location: In-person

During the meeting, we continued assembling the roller intake in CAD. While I was assembling the CAD models of the parts in Solidworks, Evie was designing a new upper roller plate for the model. We had just about finished and decided to wrap it up during the next meeting.

Task: Assemble chassis	**Build**
Date: Oct-9-21	Attendees: Nandan
Time: 4:00-6:00pm	Location: In-person

Nandan continued working on assembling the robot. He put the side and top plates on the drive pods. He learned how to use a drill to screw screws into the robot easily.

Task: Modify the roller plates in CAD And start assembling in real life	**Build**
Date: Oct-9-21	Attendees: Ryan
Time: 4:00-6:00pm	Location: In-person

Today, Evie had already finished assembling the model in CAD, so I started changing the design of the roller plates. The new design of the plates was no longer rectangular, the lower plate had a deep curve in it with rounded edges and the upper plate also had rounded edges. After laser-cutting the plates, I started assembling the roller intake.

Task: Assemble vertical arm	**Build**
Date: Oct-10-21	Attendees: Sushanth,Neha,Ethan
Time: 4:00-6:00pm	Location: In-person

During the meeting we talked to each other about what kind of belt/ pulley we should use. We decided to go with the pulley because it is more versatile and the length can be modified.

Task: Make a design that can be picked up easily	**Build**
Date: Oct-10-21	Attendees: Zack and Vaman
Time: 4:00-6:00pm	Location: In-person

I made a design that had the same 2 x 2 dimensions as a block with the technicalities to make it 3 x 3. It will be picked up by the claw and I will try and

print it soon.

Task: Finish building and test chassis	**Build/Programming**
Date: 14-Oct-2021	AttenAttendees: Amogh, Nandan
Time: 6:00- 8:00pm	Location: In-person

Programming got a drive only teleop to work on the chassis model. Amogh and Nandan worked on finishing the wiring and building of the chassis and using Amogh's code to test drive the chassis. I am pleased to say that it worked flawlessly.

Task: Finish building and test chassis	**Build/Programming**
Date: 14-Oct-2021	Attendees: Ethan, Sushanth, Neha
Time: 6:00- 8:00pm	Location: In-person

We tried recreating the plate that is holding our old arm and we kept working on the arm in CAD. Once we finished making the arm we figured out that we got the measurements wrong and then reprinted it. When we reprinted we lined it up and it fit perfectly . Next class we will work on making the arm IRL.

Task: Modify the roller plates in CAD And start assembling in real life	**Build**
Date: Oct-14-21	Attendees: Ryan, Evie
Time: 4:00-6:00pm	Location: In-person

Today we finished assembling the roller intake. After assembling all the parts needed for the roller intake, we decided to test it. It actually worked pretty well. We moved the rollers downward however, to maximize the grip of the ball and

the cube. Then we tried to see how the intake would fit inside of the robot chassis. We are currently working on that.

Task: Take apart the old odometry	**Build**
Date: Oct-14-21	Attendees: Zack, Vaman
Time: 6:00-8:00pm	Location: In-person

We took apart the old odometry and got to look at the new odometry that we were printing. We had to take out a lot of screws and come up with interesting ways to get the screws out. It ended up taking us all of the time and then it took us about 10 min. of the next day.

Task: Edit plates	**Build**
Date: Oct-16-21	Attendees: Nandan
Time: 2:00-4:00pm	Location: In-person

Nandan worked on adding holes in the top plate for the control/expansion hub and the on/off switch. He had a hard time finding a place for the things. He also had a hard time making the right measurements for the holes.

Task: Find a way to angle the intake & h how to put it in the chassis	**Build**
Date: Oct-16-21	Attendees: Evie, Ryan
Time: 2:00-4:00pm	Location: In-person

Today, we decided that the intake was going to be at a 30 degree angle instead of just plain straight. We started out by trying to angle the entire intake on the chassis but we didn't go with that idea. We also tried to see how it would fit inside the chassis. The problem was that the odometry pods were blocking the intake so we had to see how to find a way to fix that problem. At the end of the day we decided to maybe slant the shafts so that they would be angled.

Task: assemble the new odometry	**Build**
Date: Oct-16-21	Attendees: Zack, Vaman
Time: 6:00-8:00pm	Location: In-person

Today we took the new odometry that had finished printing and then we assembled it with all of the wheels, encoders, and screws. It took us the whole time because some screws were hard to reach. The new odometry had all 3 wheels in one instead of 2 wheels and we used 2 odometry pods.

Task: Angle the the intake using extrusions & how to put the intake in the chassis.	**Build**
Date: Oct-17-21	Attendees: Evie, Ryan
Time: 4:00-6:00pm	Location: In-person

Today for the angle, we decided to use extrusions to add an angle to the intake. The idea was to mount two extrusions to the intake to add a 30 degree bracket to both of them, and then add more extrusions to the bracket. That is what we did for the remainder of the meeting

Task: attach the new odometry pod	**Build**
Date: Oct-17-21	Attendees: Zack, Vaman
Time: 6:00-8:00pm	Location: In-person

When we attached the odometry pods there were problems with the frame and we had ended up remaking the plates. We ran into many problems but finally were able to modify and fix the plate.

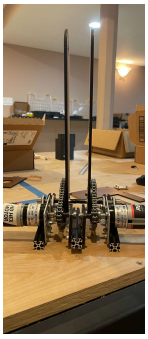
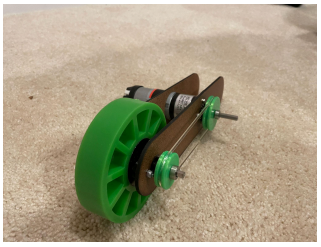
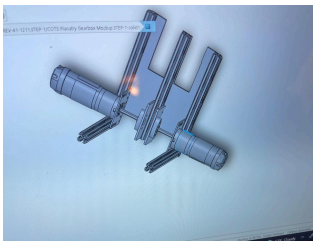
Task: Make a new prototype to work off of	**Build**
Date: Oct-21-21	Attendees: Zack, Vaman
Time: 6:00-8:00pm	Location: In-person

We made a new design that kind of looks like a top hat. It has a layer that is 3" by 3" and has many more layers that are 2" by 2". We made it 3" by 3" by 6" but we are going to make it 3" by 3" by 4" for the final build because the smaller it is, the better, and that is the smallest we are allowed to make it.

Task: Finish Arm for now	**Build**
Date: Oct-21-21	Attendees: Sushanth, Neha, Ethan

Time: 6:00pm-8:00pm	Location: In-person

We finished the intake of the arm but are still working on the platform of the arm. Our next main priority is making side plates, a bottom plate, and netting to catch it when we roll it in. Using the wheel intake. Also Sushanth was working on re-cading or arm platform/holder for our new arm.


Task: Test the new angle and see how the intake would avoid odometry.	**Build**
Date: Oct-21-21	Attendees: Evie, Ryan
Time: 6:00-8:00pm	Location: In-person

Today we tried to figure out a way the intake could go inside the robot without interfering with the odometry pods. We first tried to put the intake above the plate holding the odometry pods, but we found that the idea wouldn't be too achievable. We then thought about moving the odometry plates to make them horizontal, so there would be a big space for the intake. Nandan and Tahim are currently working on that. We also tested the intake with the extrusions as the angles. We stacked the intake on a pair of wheels and cubes and added a ramp. The test worked very well, the cubes shot out of the intake. Next we are making a possible contaminant unit for the freight.

Task: work on the gripper	**Build**

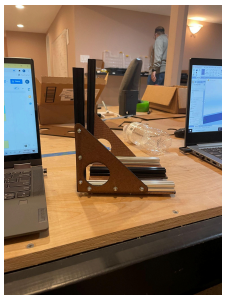
Date: Oct-23-21	Attendees: Mahati and Maddie
Time: 2:00 - 4:00	Location: In-person

Maddie and I are working on rounding the corners of the plate of the gripper. The rectangle didn't work because the grippers kept on getting stuck on the corners.

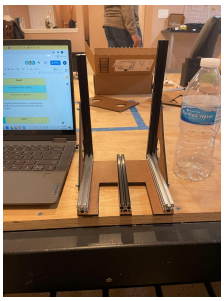
Task: Fix chassis and odometry placing	**Build**
Date: Oct-23-21	Attendees: Tahim and Nandan
Time: 2:00 - 4:00	Location: In-person

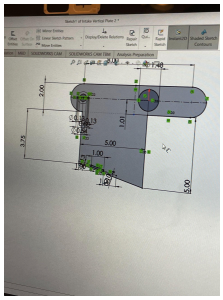
Today, Tahim worked on adding cut outs to the side plate and top plate to make space for Evie and Ryan's intake design. Meanwhile, Nandan was working on fixing the odometry placing, but ran into a problem and Nandan and Tahim switched places. Nandan started working on the cut outs, and Tahim worked on the odometry placing. Tahim's computer ran into a problem with GrabCad, so while it was being fixed, Nandan worked on submitting a form to Menchies for a fundraiser. Tahim finished the odometry pods and added it to the assembly.

Task: Coding side plates and printing arm	**Build**
Date: Oct-23-21	Attendees: Neha, Ethan, Sushanth
Time: 2:00 - 4:00	Location: In-person



We tested our arm and figured out the angle of which we have to make the side plates and Sushanth started putting together the arm platform/holder after he re-caded it. We then tested both and tested the sizes of the motor if it fits or not.





Task: Make cap stackable and redesign	**Build**
Date: Oct-23-21	Attendees: Zack, Vaman
Time: 2:00-4:00pm	Location: In-person

Today we redesigned the cap by working put all of the problems. FIrst we checked of the requirement then realized that another cap would not be balanced on ours so we built a rod coming out of our cap creating a pole-like surface. By doing this other teams don't have to adjust.

Task: Build a new mounting bracket	**Build**
Date: Oct-23-21	Attendees: Ryan
Time: 2:00-6:00pm	Location: In-person

Today I moved the mounting extrusion to the far sides of the roller plates. After removing all the nuts and screws, I mounted the extrusions to the far sides of the board. Then, I tried to use another bracket, but there the angle was too slanted. So then I started CADing my own bracket. I started off by using a 120 degree bracket, but the angle was pretty much the same as the first bracket.

Then I CADed and laser cut 3 brackets, a 135 degree bracket, a 140 degree bracket, and a 145 degree bracket. I ended up using the 145 degree bracket and currently I am working on making more brackets and applying the brackets into the intake.

Task: work on the gripper	**Build**
Date: Oct-24-21	Attendees: Mahati and Maddie
Time: 2:00 - 4:00	Location: In-person

So I am just going to use this for the past couple weeks because Mahati and I have been forgetting to do this.
The first thing we did was try to design a claw that opened and closed and would start in the robot. But it took up too much space and would not grab things properly.
Then we came up with the idea of a servo and explored the possibilities of how we could do that. We CADed the servos and made a plate to see how it would work. Then we decided on a finger design (the one we currently have) and made this
I will insert the picture when I have my phone. It is working so far but now we are adjusting the plate because the finger keeps getting stuck.

Date: Oct-24-21	Attendees: Zack, Vaman
Time: 4:00-6:00pm	Location: In-person

Today we printed the TSE and it took 12 hours so we helped out the other groups and helped cleaned up the place so we were not wasting time and were being productive. After this we will work on a different project before the event in 2 weeks.

Task: Start CADing and assembling a	**Build**
Date: Oct-24-21	Attendees: Evie, Ryan
Time: 2:00-6:00pm	Location: In-person

Today we made the bracket as a 150 degree angle rather than a 145. After CADing laser cutting the new brackets we started assembling the 'final' intake. After recutting two brand new plates and starting to finish the intake, after that there wasn't too much to do. We might be starting to make an elevator to go along with the intake.

Task: Make the opening for the freight larger.	**Build**
Date: Oct-28-21	Attendees: Evie, Ryan
Time: 6:00-8:00pm	Location: In-person

Today, we figured out that the ramp opening was too small, so we decided to make the intake shorter. After getting rid of the taller spacers and standoffs , we replaced them with shorter ones. But that only reduced the size by a little bit, so we decided to make the ramp and the box smaller, and closer to the intake.

Task: Build a platform to test the intake	**Build**
Date: Oct-30-21	Attendees: Ethan, Ryan

Time: 2:00-6:00pm	Location: In-person

Today me and Ethan built a platform on wheels to see how well the intake would work while it was moving. We got out some MDF and started making the wheels. We realized that there weren't enough wheels, so we used pulleys as the wheels instead. After we got all that set up, we tested it and it worked pretty well.

Task: Work on building robot	**Build**
Date: Oct-30-21	Attendees: Nandan, Vaman
Time: 2:00-6:00pm	Location: In-person

Nandan and Vaman worked on putting together the robot. They attached all the drive pods to the top plate and the side plates. They had to do it many times because a problem always arose.

Task: Finish the robot	**Build**
Date: Oct-31-21	Attendees: Nandan, Ryan
Time: 2:00-6:00pm	Location: In-person

Today, the intake was all ready to go, so me and Nandan went and worked on adding the control and expansion hubs, securing the lettering. We first went ahead and tried to add the expansion and control hubs by mounting one of the hubs to an extrusion and then mounting the other hub to the other hub. But that didn't work out because it was too wobbly. But the lettering was done, so we had to work on securing the lettering plates. We drilled a couple of holes,

and then threaded them so the screws would go in. Then we attached the lettering and the robot was *about* done.

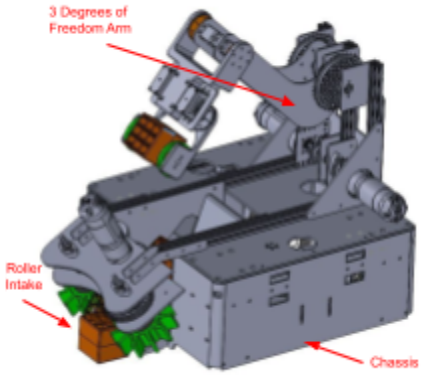
Task: Assemble the vertical intake	**Build**
Date: Dec-4-21	Attendees: Ryan
Time: 12:00-2:00pm	Location: In-person

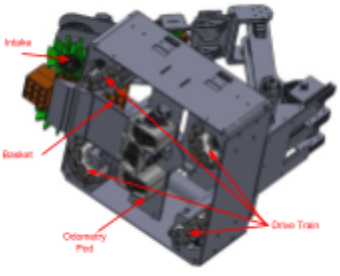
Today I started assembling the new vertical intake in replacement of the horizontal intake. I got two compliment wheels and started gathering the parts. The vertical intake needed a pivot point to be more flexible, so I made the intake a bit rotatable. Then I assembled a test chassis so I could put the intake in it to test it out. It worked pretty well, however I plan to continue working and polishing it more.

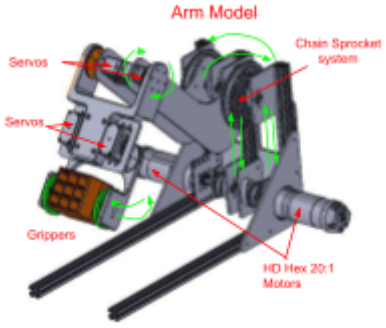
Task: Change and polish the vertical intake	**Build**
Date: Dec-9-21	Attendees: Ryan
Time: 6:00-8:00pm	Location: In-person

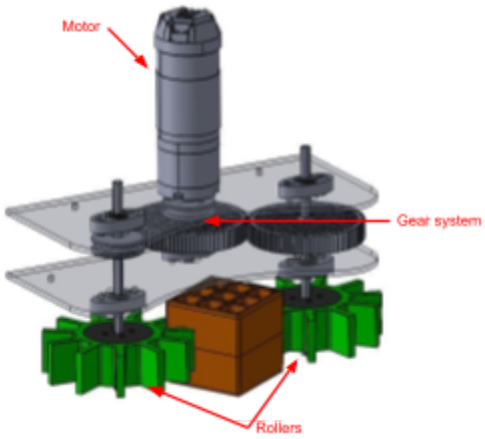
Today I tested out the new vertical intake that I had dropped off earlier. It worked very well, except for the fact that the motor blocked the arm going to level 3 and it had interference with the mounting plate. So I started working on

pushing the motor more forward in cad so there wouldn't be any more interference. Once I was done with cad. I went home to 3d print it and will take it back for testing.



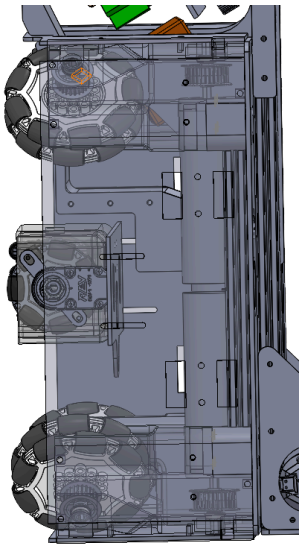




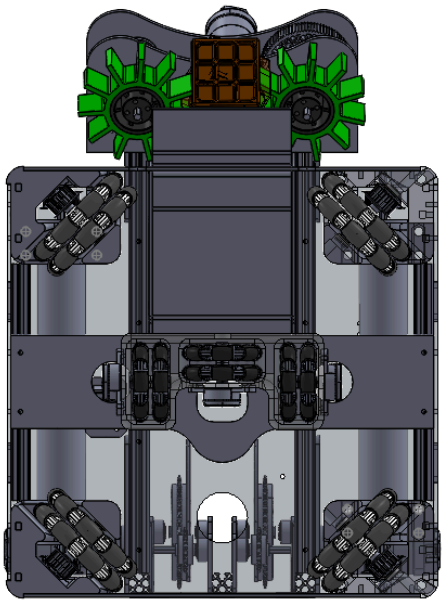


Our robot consists of six main parts; the roller intake, the gripper, the arm, the ducky disc, the drivetrain and the odometry pods. The roller intake collects cargo into a basket, and our gripper takes the cargo and places it onto the shipping hub. The gripper is attached to an arm All of these parts are connected to a central REV control hub and expansion hub. We use a REV battery to power our robot.

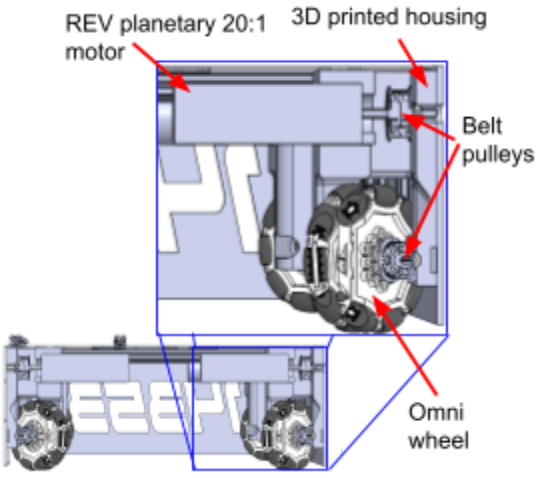
Omni-Directional Drive Train Design



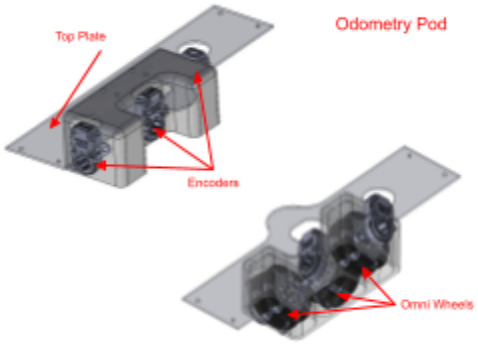
Our drivetrain is what we call a “diamond drive”. The drivetrain has 4 Omni wheels positioned at 45-degree angles. The movement of the Omni wheels combined can allow us to move forward and backward, left and right, and also turn. Two years ago, our pods had wheels attached to a motor with a chain. This caused motors to stick into the robot and take away a lot of space. We spent the entire summer redesigning the drive pods using a 3D printer. In our pods, our motors are connected to our wheels with a belt that is twisted 45 degrees. This



allows us to tuck our pods to the sides of the robot and save a lot of space to build other things like intake and odometry. Getting the spacing between the motor pulley and the wheel pulley right so that the belt had the proper tension took a long time and a lot of trials. We finally got it perfect after the fifth prototype. The pods are simply screwed into an MDF board that holds the robot together. The large MDF board is where all of our individual assemblies connect together. We also have four side plates to connect the diamond drive pods to each other.



Odometry Design



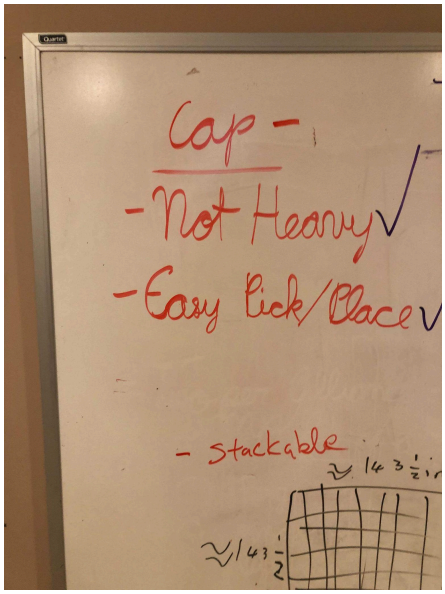
This year, we needed to have more accuracy and consistency during the autonomous period. In order to do this, we had to supply our programming team with odometry. The advantage of using odometry instead of just using the motor encoders is that we don't have to worry about the wheels slipping. It allows for a much more efficient autonomous program. Our odometry is loaded on the robot. There is a flexible board that attaches to the odometry pod which pushes on the pod from a stationary holder to ensure that the wheels always maintain contact with the ground. Whenever the robot goes over a bump the odometry moves up from the plate so that it stays encoded

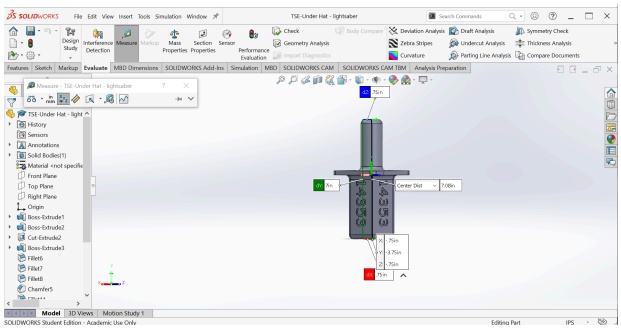
Team Shipping Element

The very first thing we did for the team shipping element (or T.S.E) was make a checklist for the requirements we needed to fix. We stated that the T.S.E needed to be able to fit on the pole of the shipping hubs. The next requirement was that the T.S.E needed to be easy to pick up and place down. This requirement may need some clarification, by easy to pick up, we needed it to be the same or similar size to a cube or a ball. Easy to place ment that it needed to have a little room for error, like you could drop it from a little bit higher up and it would still stack reliably. The next requirement is that it needs to be at least 3 by 3 by 4, and at most 4 by 4 by 8, also we needed to have the team #s on it. The last and final requirement is that we needed it to be able to stack onto other T.S.E's.

Our first thought was things like a giant cylinder. The 3 by 3 by 4 rule was really hindering us when compared to the, easy to pick and place, rule. After careful thought and many re-reads of the rules we figured out that if we made only one part of it 3 by 3, we could have the rest be 2 by 2, like the freight cube. This allowed us to solve the easy pick place rule (we could round the edges for the easy placement) and solve the size rule at the same time. We decided that this design was good but it was missing one of the rules, the stackable rule. After many hours of thinking we decided that if our teammates T.S.E can fit onto the shipping hub's pole, then if we attached a shipping hub pole on our T.S.E then they could easily put their T.S.E on ours. That is how we got our design.

Pictures:





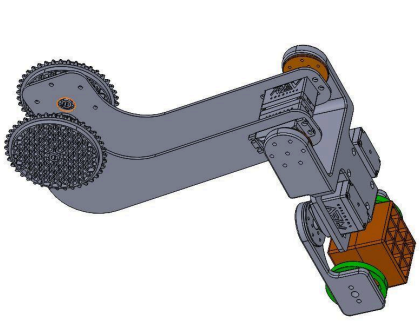
Robot arm

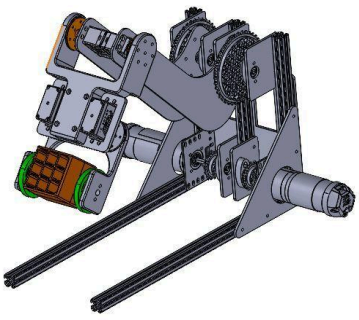
The arm for the robot is attached on the south side of the robot. This is helpful because that means that we don't need to turn around a lot so that we can do a bunch of actions with a lot less movement. The robot arm has extrusions attached to the side of the robot and this helps since the arm is really big. To compensate for this setback we decided to have the entire robot as support.

The robot has 3 joints that help make moving the arm all a lot more flexible to once again complete more tasks. The base of the arm is 7 x 7 x 7 inches because this amount of the flexibility will help us with our competition. We use this arm because it allows us to score in the shipping hub. The arm is also equipped with a gripper arm that allows us to put the capstone on the goal. The arm on the robot is a arm that is a has is a short arm because that way we have to do a lot less motion

Team Shipping Gripper

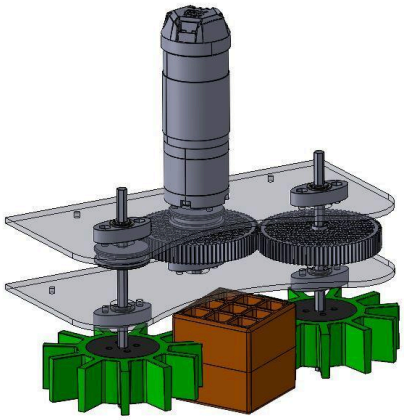
The Gripper this year is for moving items from inside of the robot that intake brought in, and move them onto the shipping hubs. The first thing I did was design it in CAD and played around with it. With some trial and error we came up with a finger and servo design. The fingers have a flat circle piece that has 5 screw holes. One of the holes is in the center and the others form a rectangle shape. The finger part is about 2.5in long and skinny with a rectangle coming off of it. The rectangle part is what picks up the freight and cargo, from inside the robot and the duckies and T.S.E. from the field. The fingers connect onto the servos and the servos connect to a plate. The plate is a rounded rectangle with two cut out rectangles and screw holes. The plate connects to the arm onto the robot.

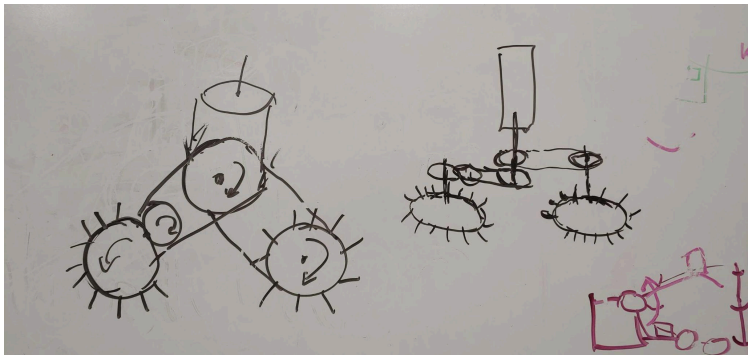




Intake

The intake sucks in cubes and balls for the gripper arm. It uses compliant wheels. We cut off the ends of the wheels so that they are more squishy and can take in both freight and cargo. The intake is slightly slanted because we figured out that at about 30 degrees, it picks up cargo and freight easier. The wheels shoot it back into the basket to get picked up by the gripper arm. There is a ramp to guide it up just in case the cargo or freight go off track. Both wheels are powered by 1 motor. We used a combination of gears and pulleys to get them to spin in opposite directions. It took many iterations to figure out how to mount it onto the chassis. There are 2 plates. On top of them is the motor, in between them are the gears and pulleys, and below them are the wheels. Having a horizontal roller intake is helpful because it can suck in items easily instead of having to precisely line up with the object. Having the compliant wheels also makes it so that the robot could be a little off, but it would still pick up freight and cargo.





Vertical Intake

The vertical intake is an improved intake for the robot. It can more precisely pick up freight without pushing all the blocks back. It is two wheels that are moved by a belt on a pulley that is powered by one motor. It is integrated into an intake mount that houses the motor. The motor is pushed more forward than the rest of the intake so that there is not any interference with the arm. The intake mount is mounted onto two side plates that are part of the robot itself. The vertical intake also has a pivot point which makes it so that it can turn a bit which makes it more flexible when picking up freight. The mount has a rubber band attached to make the pivot. There is also a ramp leading up to the pickup box.