BROWNCOATS
Team 7842 Engineering Notebook - Rover Ruckus

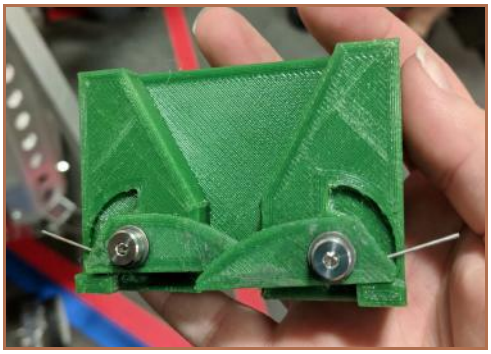
Date	Location	Start Time	End Time	Week #
October 5, 2018	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	5
Meeting Goals: Ian's drive train presentation, Continue working on lift, Test latch prototype				
Team Members in Attendance:				
Ian, Megan, Joel, Kye				

Tasks	Reflections
Robot Hardware - Drive Train	**Ian**: Today I finished wiring the drive train by adding encoder cables for each drive motor. Additionally, I presented a design review for the drive train system, including all of the newly completed modifications to the plate designs to accommodate the changes we wanted to make. The plate pocketing is estimated to save around 2lbs in weight, which is extremely significant, considering the weight limit. Additionally, I redesigned the entire connecting structure of the drive train to increase rigidity and added more mounting points for subsystems. The design now has a beam running between the two plates, and is mounted into the plate sandwich for a much stronger joint compared to the two screw joint that previously occupied that space. I also added more beams in the bottom of the space, which allowed me to add beams that ran parallel to the drive train sides. Those beams are mounted at the front and back, to pieces of extrusion that are mounted by the aforementioned plate sandwich. Additionally, in the middle, they have support beams that run down to the bottom beams.
Robot Hardware - Landing/Latching Mechanism - Latch	**Joel**: After printing the first latch, I went and started on a working model. First I went and made the latch thicker, wider, and longer, the flaps were also made bigger. I took out the tube running from the frame to where the flaps would be and put a notch at the bottom left and bottom right corners then changed all hole sizes. I then added in a torsion spring to see how big it was.

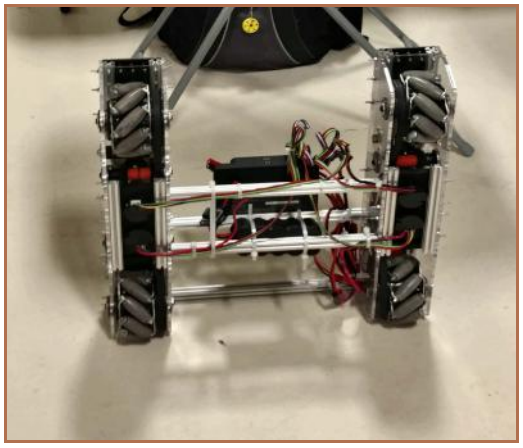
Landing/Latching Robot Hardware - Landing/Latching Mechanism - Lift	**Megan:** I continued my work on the telescoping lift. We'd ordered small belts and idler pulleys to play with, just to see if we could use belts in the place of string. The belts themselves are pretty strong, and I'm almost certain they'd be able to hold the weight of the robot. Currently, I'm more worried about the extrusion and whether or not that would be able to lift the robot. On the lift, I attached two pulleys on one side and two pulleys on the other–one at the top and one on the bottom. Using a spacer which I wrapped in duct-tape for traction, I wrapped the belt around the spacer and then tied it off with a zip-tie for an anchor point. While this works for a proof of principle, I don't think it will hold in the final product, even if I were to use multiple zip-ties. There's too much risk with the zip-ties. I'm not sure what I'm going to use to keep it in place yet, but I'm going to start looking around for different ideas. At the end of the day, I only had one side of the lift finished, and it wasn't moving smoothly, so at our next meeting, I'm going to try rearranging a couple of things.

Telescoping lift

Latch prototype



Prototype Drive Train



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Team 7842 Engineering Notebook - Rover Ruckus

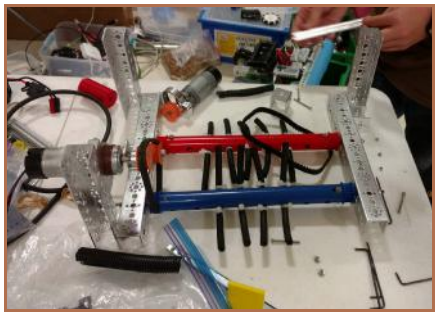
Date	Location	Start Time	End Time	Week #
October 6, 2018	AvaLAN Wireless	12:00 p.m.	5:00 p.m.	5
Meeting Goals: Stringing the belts on the lift, Version 2.0 of the latch prototype,				
Team Members in Attendance:				
Ian, Megan, Brooklynn, Joel, Kye				

Tasks	Reflections
Robot Software - Autonomous	**Ian**: With the drive train wiring completed yesterday, I began working on autonomous. First, I modified my modular autonomous subsystem structure (which I coded over the summer) to support the new drive train. This included changing constants, such as for the new drive train ratio (16:1 this year vs. 20:1 for the robot I coded the structure on), and modifying the hardware map to fit. Additionally, I started work on an OpenCV detector to determine the sampling field order in autonomous.
Robot Hardware - Landing/Latching Mechanism - Lift	**Megan:** My goal was to finish stringing the belts on both parts of the lift and finish the day out with a design review to the rest of the team. What I did first was finish stringing the lift. Once I'd finished that and tied off the belts to all of the anchor points, I took the 3d printed spool Ian designed in SolidWorks and began testing where to put it. I attached two small Tetrix beams to the extrusion and put the spool on an axle. I wasn't trying to motorize it today–I just wanted to see if the belts would work, and I wanted to present my design review to the team. I had a lot of difficulty aligning the belts so that they wouldn't get tangled around each other. Once I'd put all of the belts where I thought they'd work, I tried turning the spool by hand to see if it would go up and down smoothly. It worked at first, however, as it was going up, one of the zip-ties from the belts snapped. With the help of the team, we determined that it was due to the fact that the belt on the spool was too short, and it wasn't wrapped around the spool enough for it to hold the belt in place. I'd run out of belts at this point, so at our next meeting when I have more belts to work with, I'm going to swap out the belt that's currently on the spool with a longer one.

Robot Hardware - Landing/Latching Mechanism - Latch	**Joel**: I added an indention around the holes on the frame so the torsion spring could fit snug. I also added long pipe holes for the torsion spring rods, then added a little extruded notch on the flap so it would hold the other torsion spring rod. Then my dad printed it and ordered the parts but this time instead of having just one screw we bought I different screws and some collars to fit around it so the torsion spring could rid on it without friction and we bought some torsion springs. Now version 2.0 is finished.
Robot Hardware - Collector/Dispenser - Sweeper Intake	**Brooklynn**: I helped Joel with his proof of principle for a sweeper-based collector system. The POP had 3 sweeper tubes, 2 on bottom and 1 on top. What we mostly tried to work out was the height for the top sweeper tube so that it could share a motor with one of the bottom tubes. We soon realized that the sweeper arm would be touching if we did this, but we hoped that it wouldn't be too much of a problem. By the time the meeting ended, we decided we needed a different approach.

Stringing the telescoping lift


Joel giving his Latch presentation


Sweeper Intake POP

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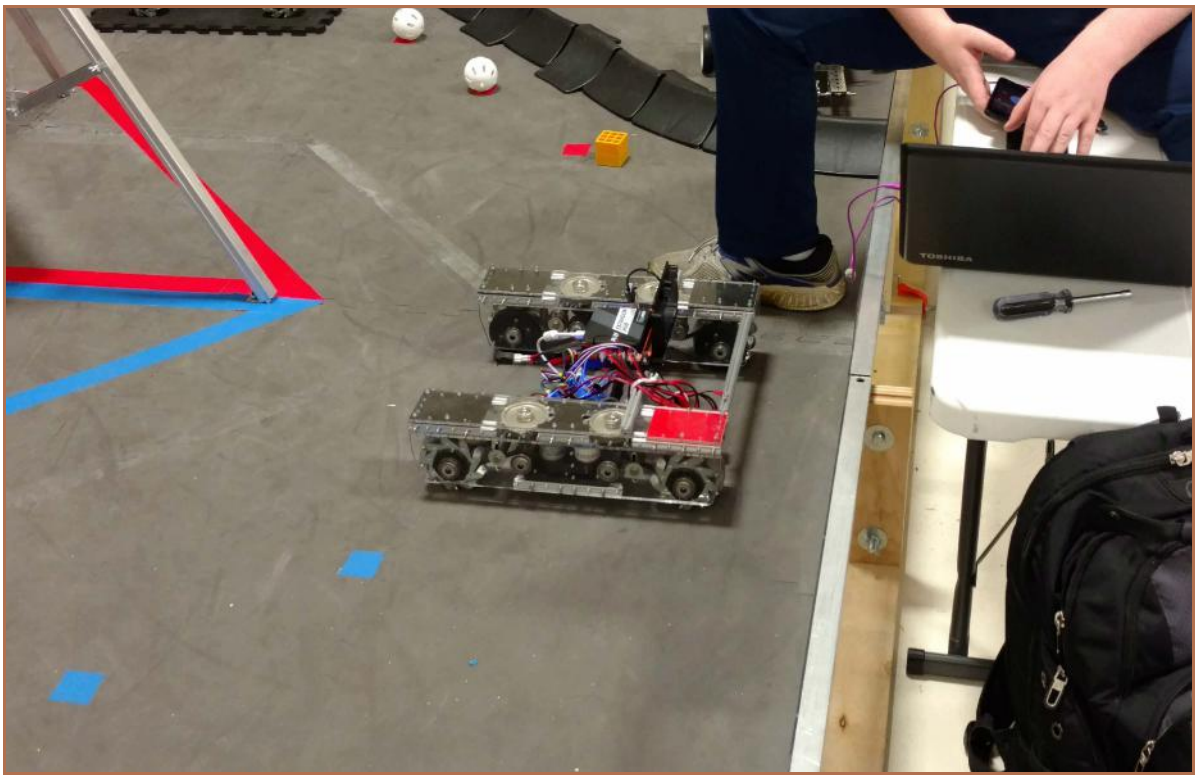
Team 7842 Engineering Notebook - Rover Ruckus

Date	Location	Start Time	End Time	Week #
October 8-11, 2018	Ian's Home	Various	Various	6
Meeting Goals: Begin robot navigation tuning				
Team Members in Attendance:				
Ian				

Tasks	Reflections
Robot Software - Autonomous	**Ian:** Over the week, I primarily worked on the beginnings of robot navigation tuning, as well as the sampling order detector. The latter objective turned out to be far trickier than I was expecting. The phones we use, ZTE Speeds, have very poor cameras. Additionally, the field-of-view (FOV) of the rear camera is leaving a lot to be desired. The front (or "selfie") camera has a much larger FOV, but its resolution is also much lower. After some testing, I discovered that the FOV of the rear camera is *just barely* wide enough to see all three elements in the sampling field from a distance that I estimated the phone will be at after landing. Knowing this, I created an OpenCV pipeline (essentially an image processing pipeline, to go from a static captured image to a static filtered one) to blur the image (to reduce noise) and filter out anything that wasn't yellow. From there, the pipeline searched for contours in the image, and then filtered for contours that matched specific criteria that I set. After testing this pipeline, I discovered that all of the objects in the images the camera returns are too small to be effectively filtered for contours, thus making it very difficult to discern between remaining noise and the actual target object. To try to circumvent this, I added a step to the pipeline to expand any object in the image that matched the color filter (in this case yellow objects, which includes the target, yellow cubes). The testing results from this were promising, as it doubled the range of the detector (from about 6" to about 12"). However, the range was still extremely short of where the robot would be after landing, and due to the limited FOV of the camera, being that close to an element blocks the other two from view. I revisited my pipeline, and tuned how many times the filtered objects were increased in size.

Robot Software - Autonomous (continued)	After increasing the iteration number substantially, I reached the desired range of the detector. The accuracy also seems to be fairly high. Something that I'm concerned about with this solution, however, is that if the camera can see cubes within the crater, the detector will likely return a false reading. This is because the effective large mass of yellow objects will almost certainly be returned, instead of the desired sampling field cube.



Ian working on autonomous

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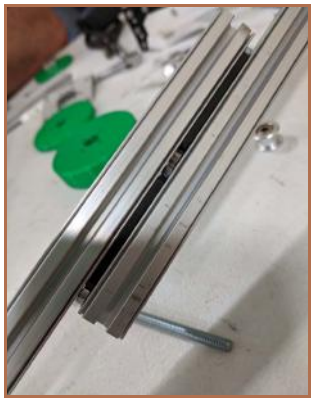
Date	Location	Start Time	End Time	Week #
October 12, 2018	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	6
Meeting Goals: Continue to build telescoping lift, Begin work on display boards				
Team Members in Attendance:				
Ian, Megan, Joel, Kye, Jalynn				

Tasks	Reflections
Robot Software - Autonomous	**Ian**: I continued work on autonomous today. I started by testing my sampling detector on the field, to see if my results were similar to what I got over the week. Something that I discovered while I was testing was that the drive train sides block the edges of the camera FOV. This prevents the camera from being able to see all three, or even two elements in the sampling field. A possible solution for this is to determine the sampling order while hanging (which would allow us to angle the camera down and prevent the issue from happening), and then act on that information as normal after landing. Other than that setback, the detector seems to work very well, but it is definitely thrown off by elements in the crater. We're considering a few options for this. The first is to angle the phone enough to block view of the crater (since we'll be angling the phone anyways), and another is to add a "shield" above the camera to shorten the vertical FOV. After confirming that my detector worked, I returned to navigation. Once I was satisfied with the positional and velocity PID gains, I began planning out the various paths necessary. I then began coding those paths, starting with the easiest path. That path being the depot corners of the lander, when the cube is in the center sampling position. In order to circumvent the lack of a sampling detector, I created a simple toggleable option to switch between the three positions. All of the autonomous logic should be fairly transferrable between this solution and the actual detector, because the variables used are the exact same.

Robot Hardware - Landing/Latching Mechanism - Lift	**Megan:** I continued my work with the telescoping lift. Now that I had demonstrated my proof of principle to the rest of the team, I could begin building a prototype of the final lift for our first Arkansas qualifier. The first thing we did was cut new pieces of extrusion. The ones I used for the proof of principle were scarred and too long. Instead of using six 16" pieces, I went with four 14" pieces. I attached two of the beams together and then I attached the other two beams together, so that I had two separate sliders to mirror the lifts. After that I started looking at how to attach the two separate lifts to each other. I didn't want to use more REV extrusion to attach them, because even though this was sturdy in my proof of principle, I wasn't convinced that it would be rigid enough. So, I decided to attach the pulleys for the belts in the middle of the mirrored lifts, using a long screw that I would put through the extrusion and hold it off with a locknut. Not only would this work as a way to keep the pulleys from slipping, it also acted as a way to attach the two lifts. Because I decided to do this, we would need to drill holes in the extrusion, so I measured the extrusion and decided where I wanted the bolts to be, and then I handed it off to one of the mentors so that it would be cut and ready for the next meeting.
Display Boards	**Kye**: Jalynn and I put cork strips on two of the cork boards. When we got finished with the cork strips we started cutting the photos that were printed for the outreach board. After cutting the photos, we put them on the cork boards. While we were coming up with the layout for the photos and their descriptions, I integrated the use of a technique I learned at art class of drawing the eye to the photo.

Anchoring the sliders in the telescoping lift



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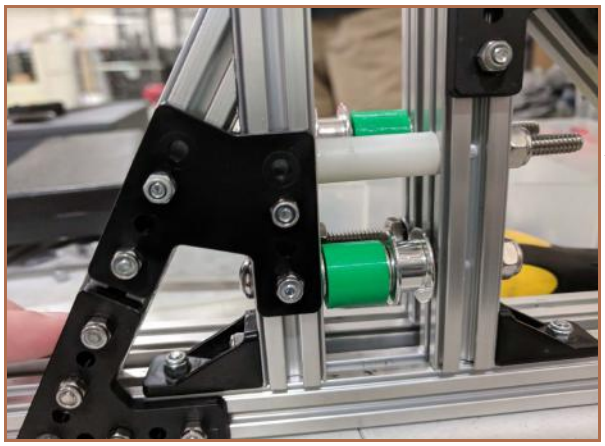
Team 7842 Engineering Notebook - Rover Ruckus

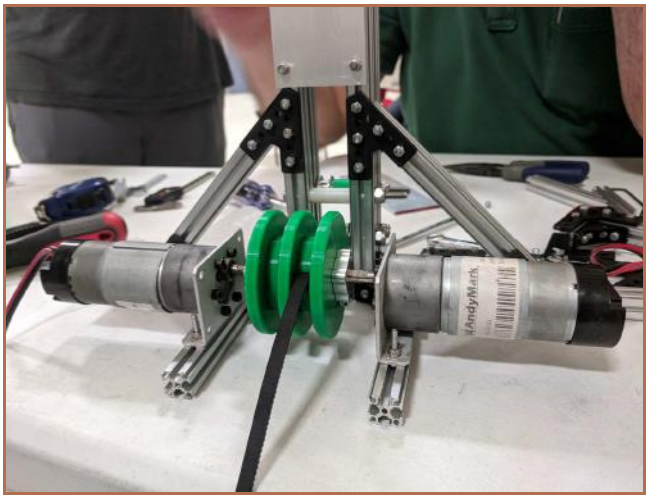
Date	Location	Start Time	End Time	Week #
October 13, 2018	AvaLAN Wireless	12:00 p.m.	5:00 p.m.	6
Meeting Goals: Practice driver controls, Finish display boards				
Team Members in Attendance:				
Ian, Megan, Kye, Brooklynn				

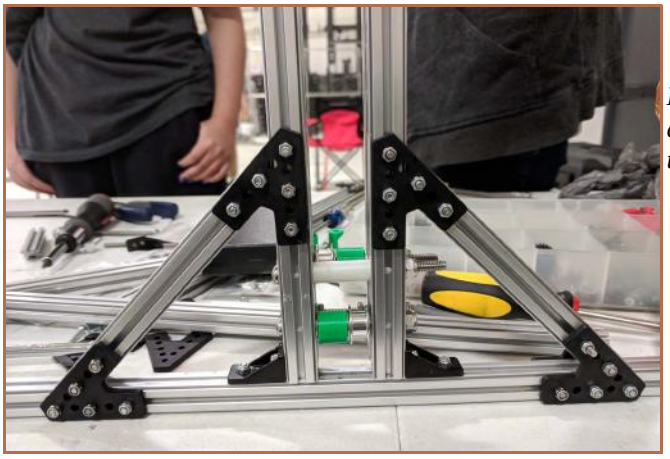
Tasks	Reflections
Robot Software - Autonomous	**Ian**: I continued work on autonomous today. By the end of the day, the robot was able to push the center element into the depot, and I began work on the paths for the other two element positions.
Robot Hardware - Landing/Latching Mechanism - Lift	**Megan**: I continued my work with the telescoping lift. Our mentors had drilled the holes in the extrusion, so I put all of the pulleys and screws in, along with any anchor points that would be needed for the belts. After that, I started thinking about how I could mount the motors. I could have mounted it directly onto the lift itself, but I decided the easiest way to start out would be to attach a beam of REV Extrusion to the bottom of the lift and attach two more that would hold the motors. We decided to have two motors on either side of the pulley that would power the lift. I put quite a few brackets on the pieces of Extrusion to try for rigidity, however, while the brackets did help, there was still quite a bit of it that would move. So, I took two diagonal REV Extrusion beams and attached those to either side of the lift using brackets, and attached the other side to the beam holding the motors. While this helped a great deal, towards the end of the meeting, we noticed that the lift was still being pulled towards the motors, so I decided to try mounting the motors directly to the lift at our next meeting.
Display Boards	**Kye**: Brooklynn and I, with help from mentors, hot glued the strips that were falling off the cork boards. The outreach photos needed to be trimmed to make everything fit better. I then put them back in place with some adjustments. Brooklynn cut our Sponsors logos to put on the board. The Vera Mk. 6 half of the board could not be completed because we did not have enough photos.



Pulleys and spacers mounted to the telescoping lift

Initial motor and spool mounting on the telescoping lift





Diagonal bracing attached to the telescoping lift

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Team 7842 Engineering Notebook - Rover Ruckus

Date	Location	Start Time	End Time	Week #
October 19, 2018	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	7
Meeting Goals: Collector Intake Prototype, Continue working on lift, Picture Day				
Team Members in Attendance:				
Ian, Megan, Brooklynn, Joel, Kye, Jalynn				

Tasks	Reflections
Robot Software - Autonomous	**Ian**: Autonomous work continued throughout the day today. The navigation software is working surprisingly well and pain-free so far. The paths for the outer element positions showed significant progress today, and are almost complete.
Robot Hardware - Collector/Dispenser - Sweeper Intake	**Joel:** I began thinking about a sweeper intake as a POP again. In prior years, the team had made sweepers from zip-ties and surgical tubing wrapped around a 3D printed rotating shaft, dubbed an "octobar" after its eight-sided shape. I asked that three new octobars of a short length, just long enough for two minerals to be picked up side by side, be 3D printed. I then assembled these onto a motorized frame so that the minerals would be picked up and eventually lifted into a bin. I had to take off all the octobars and drill some of the holes bigger for the tetrix axle hub. Then, I put all the hubs on the axles and attached them to the octobars. I added a belt pulley onto the axles and attached them to the frame with a one flower tetrix beam. I put one octobar at the ends of the frame. I then added an extrusion, standing up, in the middle of each side of the frame using a corner bracket.
Robot Hardware - Landing/Latching Mechanism - Lift	**Megan**: I began mounting the motors to the lift itself, instead of beneath the lift. Even so, I kept the beam below the lift on, just in case we would need to use that to mount the lift to the robot. I'd had plates mounted on either side of the lift vertically, however, on the stationery side of the lift, I changed the plate to horizontal. After that, I mounted the motors to the plate and then we finished stringing the belts. We were having issues with tension problems though, so we're going to look at that in more detail at our next meeting.

Robot Hardware - Collector/Dispenser - Collector Arm	**Jalynn**: Today I pitched a collector arm design with help from Brooklynn, Kye, and Mr. Jeff. The basics of my design was that it had a cupped opening with a lid to scoop up the minerals (blocks and cubes). Inside the cup, there is a hook that would latch *over* not through the latch on the landing. When, there is a mineral in the cup, the arm would rise over the mineral dispenser and the cup would spin around using a servo to deposit the mineral. I also that the hook inside could be multi-purposed and push the mineral out of the cup as well. The main problem I had was figuring the arm, but then Megan had answered that problem when she pitched her telescoping arm design.

Jalynn demonstrating her concept for an arm and bin for collecting minerals then depositing them into the cargo hold

Testing autonomous

Testing the 3D printed prototype of the latch mechanism

Jayne Weeble - the team's marker and new mascot

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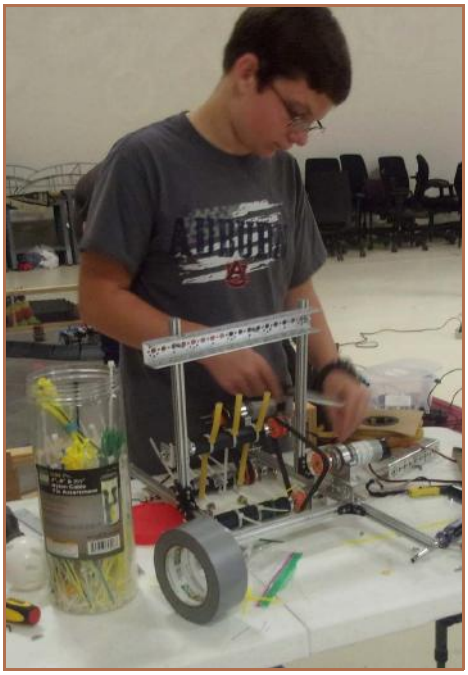
Team 7842 Engineering Notebook - Rover Ruckus

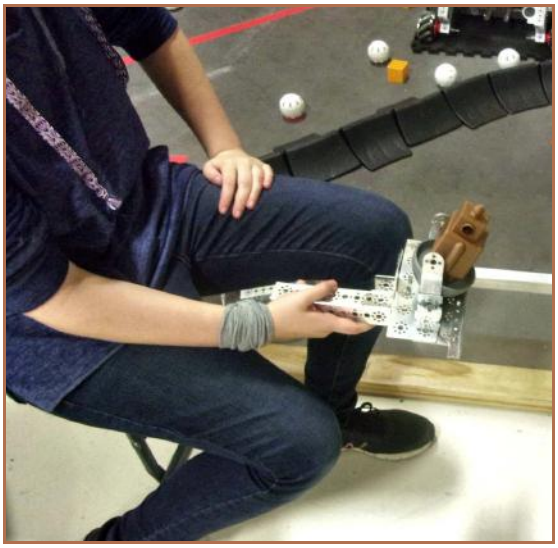
Date	Location	Start Time	End Time	Week #
October 20, 2018	AvaLAN Wireless	12:00 p.m.	5:00 p.m.	7
Meeting Goals: Continue working on Collector Intake Prototype, Begin working on Marker Dispenser, Discuss judging, Continue working on Display Boards				
Team Members in Attendance:				
Ian, Megan, Brooklynn, Joel, Kye				

Tasks	Reflections
Robot Software - Autonomous	**Ian**: I completed the outer paths for the depot side elements. So far, it's been very consistent. I also tested the paths on the blue side, and they worked just as well as on the red side. I then began laying out the paths to reverse into the crater and park. Unfortunately, I didn't get to test them, because I ran out of time.
Robot Hardware - Collector/Dispenser - Sweeper Intake	**Joel:** After what I did on the 19th, I added another octobar onto two axles. I put them into a one flower tetrix bar that was slipped onto a belt pulley, put on bronze bushings, and added a belt. Then, I attached a tetrix motor mount onto a three flower tetrix beam and attached that to the extrusion. I also added zip-ties to all the octobars and put surgical tubing on the zip-ties. Then I put a motor on the motor mount, put a belt pulley on the motor shaft and attached the belt. Finally, I tested the assembly, figured out the surgical tubing is not sturdy enough to pick up cubes and balls, and went to the store to buy better tubing and zip-ties.
Robot Hardware - Marker Dispenser	**Brooklynn**: I was tasked with building an arm that will put the marker into the Depot during autonomous. The holder part of the arm would have 3 "fingers" on 3 sides leaving one side open for the marker to be able to drop out. The holder would be attached to a servo that would move up and down on the robot. It took a couple of tries to make the 3 fingers have enough room but not too much room between them so that the marker doesn't slip out when the robot moves around. To drop the marker, the servo only has to go a little less than horizontal until gravity just makes the marker fall out.

Judging	**Megan**: the team sat down to discuss how we want to approach our judging presentation. Last year, we spent a lot of time discussing the outreach we completed throughout the season. And while we did discuss the robot and the programming, after reflection, we realized there wasn't enough balance between the two. So, this year, we decided that after we introduce the team, we'll do an overview on the robot, demonstrate it for a moment, do a quick overview on outreach, and then some of the goals we set over the summer. After that, the next few people to talk will discuss what they built on the robot, or what they programmed, and when it comes back to the original speaker, they will go into more depth about outreach and finish with a conclusion.
Display Boards	**Kye**: Today, we finished the display boards by finishing the team board. We were trying to figure out what order we wanted to put the team pictures in, and if we wanted to use both out of costume and in costume photos on the board. We finally decided to use both sets of photos.



Intake System



Marker Dispenser

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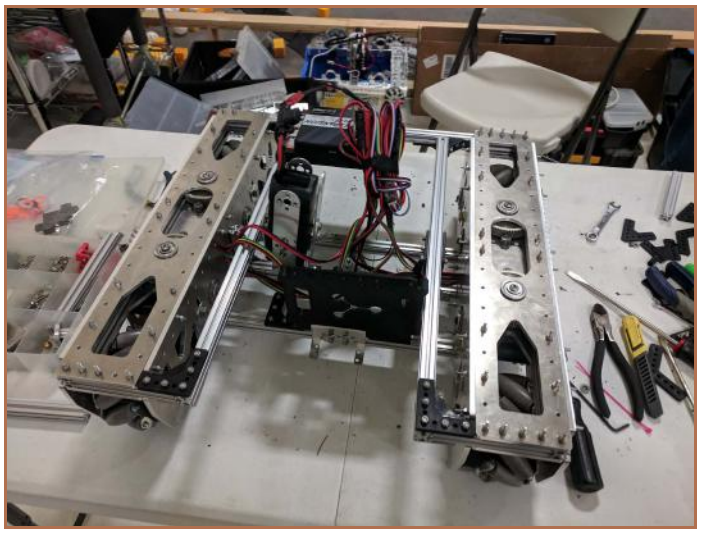
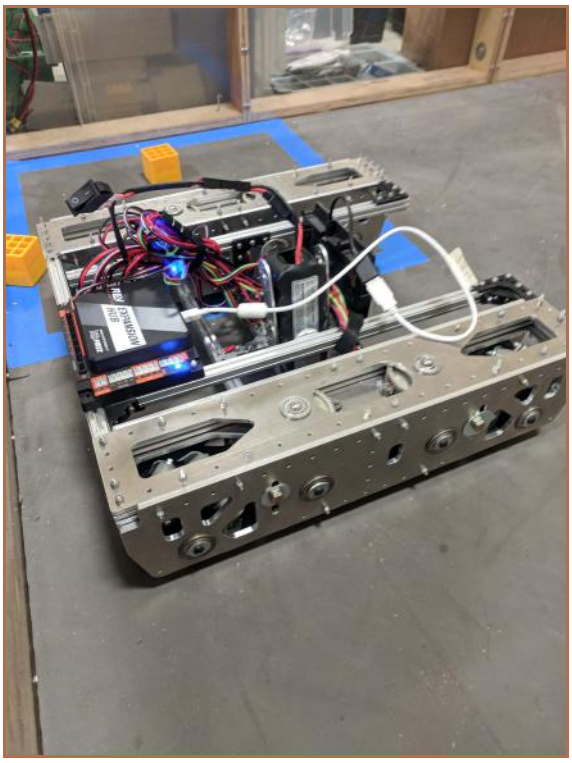
Team 7842 Engineering Notebook - Rover Ruckus

Date	Location	Start Time	End Time	Week #
October 25, 2018	AvaLAN Wireless	2:00 p.m.	5:00 p.m.	8
Meeting Goals: Finalize drive train hardware, Wire routing				
Team Members in Attendance:				
Ian				

Tasks	Reflections
Robot Hardware - Drive Train	**Ian**: During the week prior to the meeting, the drive train CAD files were delivered to Midway Machine Shop, where the drive train parts were cut out of 3/16 inch aluminum. The parts were delivered Monday, October 22, and I've been disassembling the acrylic drive train and reassembling with the aluminum parts. I finished the connecting drive train structure today, as well as rewiring the robot to better utilize the new cable routing holes in the metal plates. Previously, I had the cables running dangerously close to spinning axles, which I changed by drilling a hole in the motor support blocks and feeding cables through that. It's a much cleaner setup overall, and there's little to no chance of wires getting caught in the gears.





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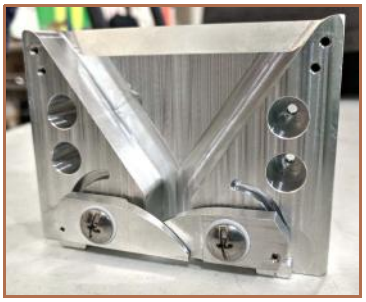
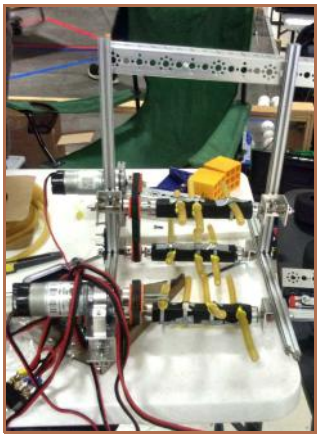
Date	Location	Start Time	End Time	Week #
October 26, 2018	AvaLAN Wireless	2:00 p.m.	6:00 p.m.	8
Meeting Goals: Continue working on Autonomous, Put Latch on Lift and Test				
Team Members in Attendance:				
Ian, Megan, Joel, Kye, Jalynn				

Tasks	Reflections
Robot Software - Autonomous	**Ian**: With the drive train completely rebuilt, I returned to autonomous work. I encountered some difficulties as I was trying to test the parking paths that I worked on a week ago. I think the cause might be the performance differences between the acrylic and aluminum drive trains. Additionally, we greased the gears when we rebuilt it, which may further contribute to the unexpected behavior. I will do some more testing and observation tomorrow to see if the cause might be my code or if it is indeed physical robot changes.
Robot Hardware - Landing/Latching Mechanism - Lift	**Megan**: I continued my work with the telescoping lift. We figured out that the reason the tensioning wasn't working correctly is because when the belts wrapped around the spool when it was fully extended or fully retracted, the distribution of belts between the two sides of the spool weren't even. The only time the tensioning was ever correct was when the lift was in the middle. To help take some of the stress off the belts, we added a spring to the bottom of the belt that was used as an anchor point. We also 3D printed blocks that would hold the tied off belts in place, so we wouldn't have to worry about them slipping or snapping out of the zip-ties. Once all of this was finished, we tested the lift using a ziptie to hold it on the lander, and then we placed about 37 pounds of weights onto the bottom of the lift. It was able to lift them easily, however, it wouldn't stay up once we got them to the top, so at our next meeting, we're going to try and create some kind of latch or stop to keep the lift in place.

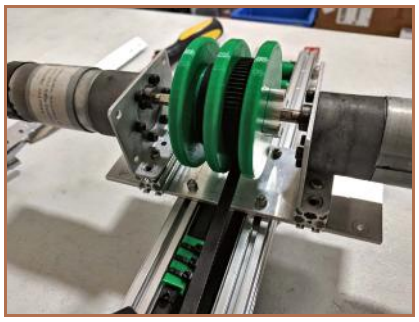
Robot Hardware - Landing/Latching Mechanism - Latch	**Megan**: Towards the end of the day, the latch for the lift arrived, fully cut in metal. We placed weights in a bag one by one, and then we wrapped the bag straps on the latch and lifted them by hand to see if the latch could handle the weight. To our delight, it worked incredibly well! We began brainstorming ways to attach the latch to the lift, and at the end of the meeting, we decided we'd try putting a plate on the moving side of the lift, and then attach the latch to that plate. **Joel**: We tested the final version of the latch by first seeing if it could latch, then we added weights to the flaps to see if it would break. The test was a success.
Robot Hardware - Collector/Dispenser - Sweeper Intake	**Joel**: I got a CAD file of a belt pulley of Vex robotics and added cylinder to the bottom so it could fit inside some PVC pipe. Then I added some screw holes for tetrix screws, and I added a hole inside the cylinder big enough for a collar to fit in it (all of this was done in Solidworks).



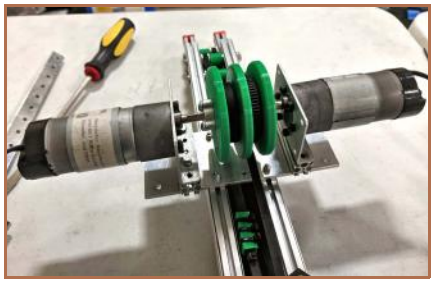
Final, Aluminum Latch mechanism



Sweeper Intake POP



Assembled lift. Note the difference in the diameters of the belt wound onto the two sides of the spool

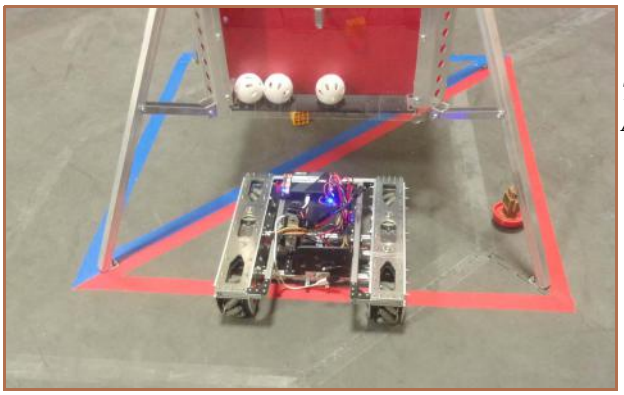


Assembled lift. Note the green block at the bottom of the frame - used to fasten the end of the belt so that it won't slip

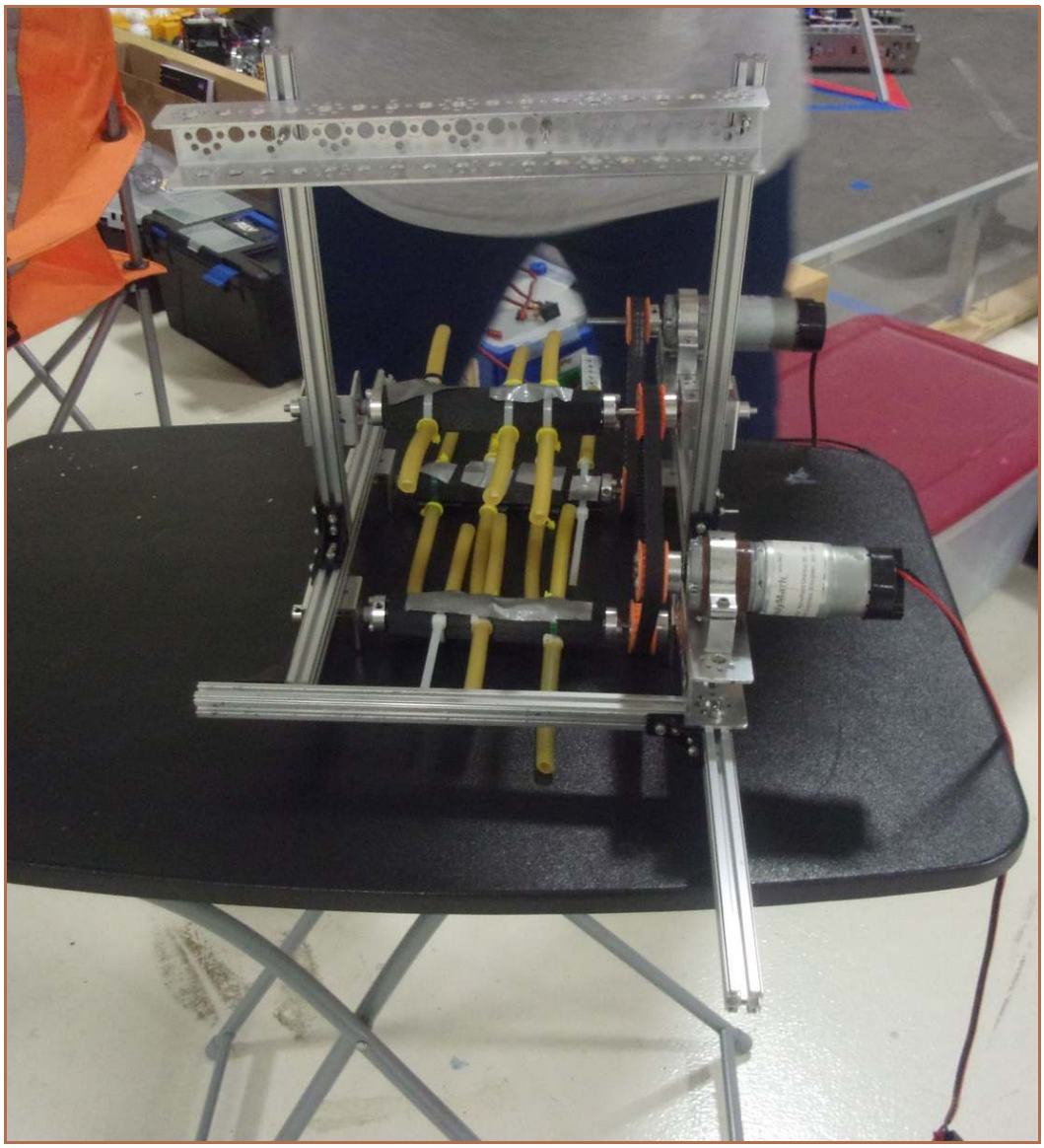
BROWNCOATS
Team 7842 Engineering Notebook - Rover Ruckus

Date	Location	Start Time	End Time	Week #
October 27, 2018	AvaLAN Wireless	12:00 p.m.	5:00 p.m.	8
Meeting Goals: Debug Autonomous, Hardware assembly, Collector POP				
Team Members in Attendance:				
Joel, Kye, Ian, Jalynn				

Tasks	Reflections
Robot Software - Autonomous	**Ian:** I did make some autonomous headway today, but the unexpected behavior still continued. What's more, the behavior seemed inconsistent at best. One run would work just fine, and another would spin out of control and ruin the whole attempt. Needless to say, that's not desirable for autonomous in general, but especially not when our strategy for Arkansas relies so heavily on a consistent autonomous. I plan on re-tuning the controller gains and certain drive train constants to see if that is indeed the issue.
Robot Hardware - Collector/Dispenser - Sweeper Intake	**Joel**: I sanded down some 3D printed parts to fit correctly. I cut holes in some PVC pipe for the tubing we bought last week. I then attached a bronze bushing to the 3D printed part and put a collar on an end of an axle and slipped the free end of the axle through the bushing. Then I put that whole assembly on each end of the PVC pipes. I took some tubing off an old assembly and put it though the holes in the PVC.



Testing Autonomous



Proof of Principle Sweeper Intake

BROWNCOATS
Team 7842 Engineering Notebook - Rover Ruckus

Date	Location	Start Time	End Time	Week #
October 28, 2018	AvaLAN Wireless	11:00 a.m.	4:00 p.m.	8

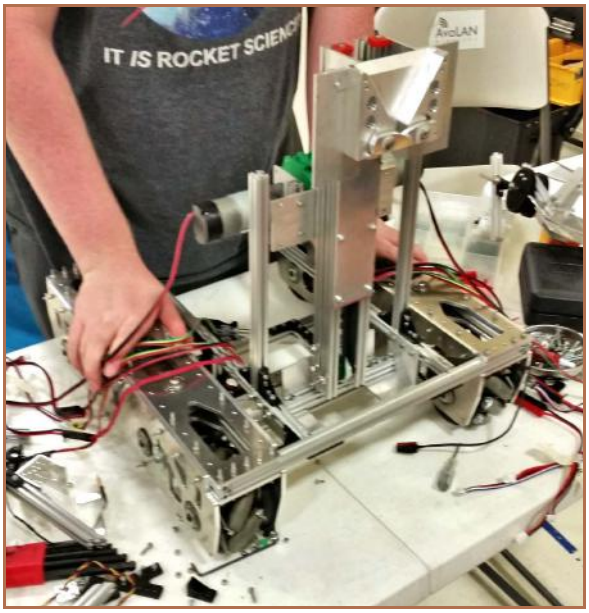
Meeting Goals: Assemble all hardware

Team Members in Attendance:

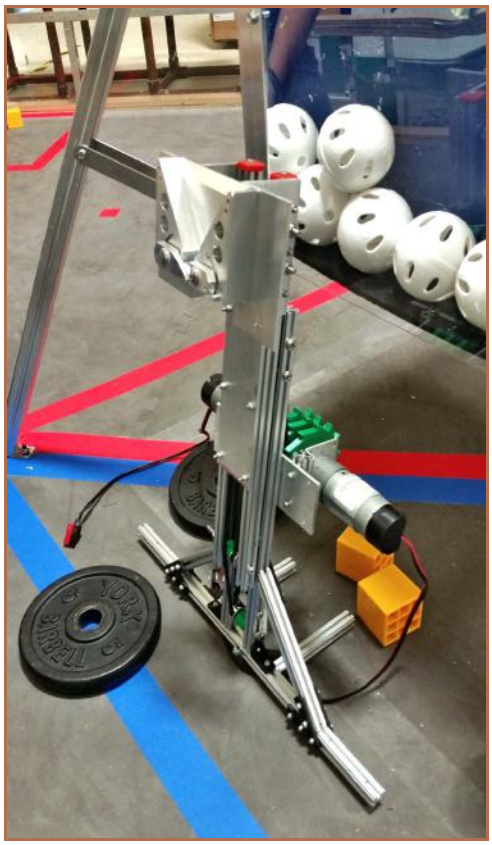
Ian, Megan, Joel, Brooklynn

Tasks	Reflections
Robot Hardware - Landing/Latching Mechanism - Lift	**Megan**: The team met for an extra meeting in hopes of having everything mounted and integrated on the robot by the end of the day, so we'd be able to completely focus on programming at our last weekend of meetings before our first Arkansas Qualifier on November 10th. Ian and I worked together on the lift to get it mounted onto the robot. I took off the bottom beam and the two REV extrusion beams that were originally used to hold the motors in place before we moved the motors onto the lift. After that, I mounted the latch onto the front of the lift using four screws and locknuts. Then, the whole team began brainstorming different ways to mount the entire lift onto the robot. We decided that it would need to be at least two inches off the ground, if not a little more. And because the latch was not directly mounted onto the lift–rather on two plates–it stuck out a little bit, so we needed to place it a little farther back in the robot to make sure we stayed within the constraints of 18". We took two angled metal plates and placed them on either side of the middle of the drive train, and we connected a beam of REV extrusion on those plates. While we weren't able to completely mount the lift to the robot by the end of the meeting, we were able to attach it to two plates, which were attached to support beams in the middle of the drive train. **Ian**: Today was primarily a hardware day. We removed the electronics (which unfortunately meant that I couldn't experiment with new controller gains to see if I could reduce the inconsistent behavior that I experienced yesterday), and then began mounting the lift. We made steady progress with the lift integration. By the end of the day, we successfully mounted the lift to the robot. The surrounding structure does need to be improved, however, as there's a lot of twisting that can occur. We're planning on supporting the lift near the top with extrusion in the same plane as it to reduce side-to-side wobble. Additionally, we're going to reduce front-to-back wobble by using some diagonal pieces to support the lift, thus creating a very rigid triangle.

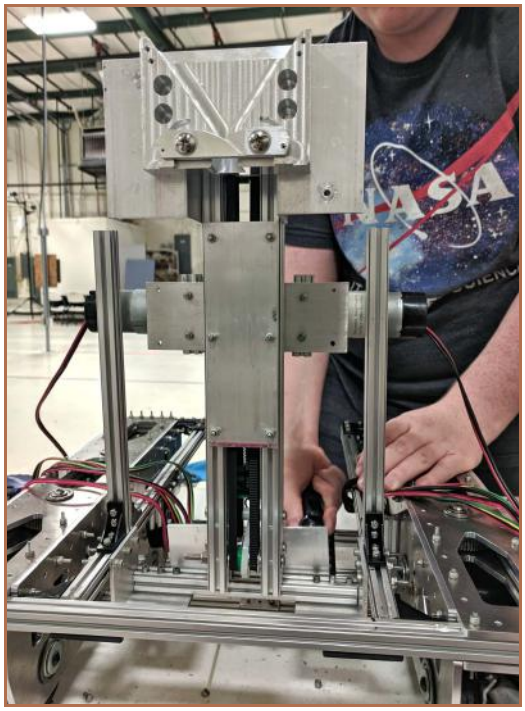
Robot Hardware - Landing/Latching Mechanism - Lift (continued)	**Brooklynn and Joel**: We thought about how to build a pawl to engage a newly printed spool that will keep the robot from slipping to the ground when power is removed from the lift motors. Our ratchet and pawl was created by attaching two plates, one that could hold a servo, to the motors, and then attaching an axle to a tetrix one flower beam and placing the pawl on the axle. Then we attach a 3D printed servo horn, that has a horn, to the servo, allowing the horn to push the pawl out of the ratchet. The pawl would be attached to a rubber band that would pull the pawl into the ratchet when the servo horn was not pulled back.
Robot Hardware - Collector/Dispenser - Sweeper Intake	**Joel**: We put the belts on the PVC pipes by taking one side of the PVC off the frame and slipping on the belt then attached the PVC back on, we did this to all of the PVC. Then we attached the belts to the motors. After all of that, we put zip ties on each side of the tubing that is in the PVC so they do not slip out when we test it. We tested the intake and found out that the tubing needs to space farther apart from each other because the tubing hit each other causing the belt to skip. **Brooklynn**: I helped Joel work on his sweeper intake by putting on the motors and adjusting the positions of pulleys and belts.
Robot Hardware - Marker Dispenser	**Joel**: For the marker dispenser, I attached two legs to the dispenser Brooklynn made to allow it to spin on an axle. I had to take all of that off so it could fit on the drive train and Brooklynn helped reattach all the parts back. **Brooklynn**: Today we had the goal of putting all of the parts/systems on the drive train. I helped Joel with modifications to the marker dispenser system.



Integrating the drive train, the lift, and the latch

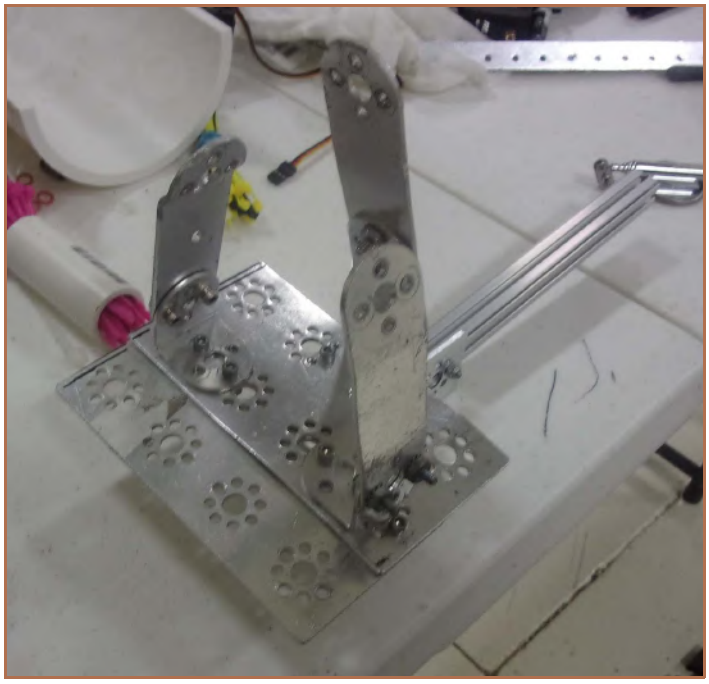


Lift with Latch attached



Lift with Latch attached

Brooklynn and Joel working on the Sweeper Intake



Marker Dispenser