Introduction to Engineering Disciplines - E-87
Lab Book

Project Name: Combat Robotics
Professor/Grad Student: Noah Smith and Claudia Adelman
Team Member Names and Roles: Erick Gonzalez, Lorenzo Cova, Rogelio Rodriguez and Victor Acuna

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Instructions: Using the template below provide lab book entries. Entries can include notes, pictures, charts, etc. Be specific with the information written about the project. Your team will use these notes to create the final PowerPoint presentation. Each team member must make at least 1 entry each week.

Week 3
Entry Date: October 11, 2022
Entered By: Victor Acuna

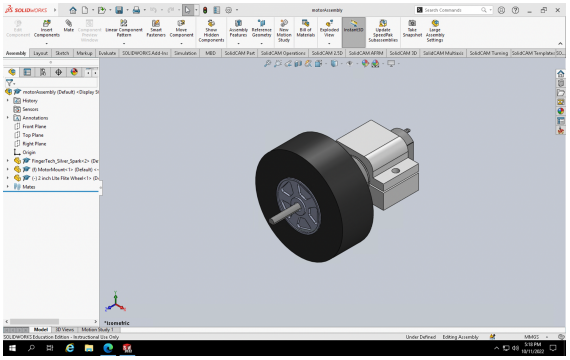
Notes:

Our work week began on Tuesday. In our meeting, we went over the "Drivetrain and Chassis Design" slides. In those slides, our instructors began to inform us about what we can and cannot use in terms of materials and weapons, as well as what they recommend we should have in our design.

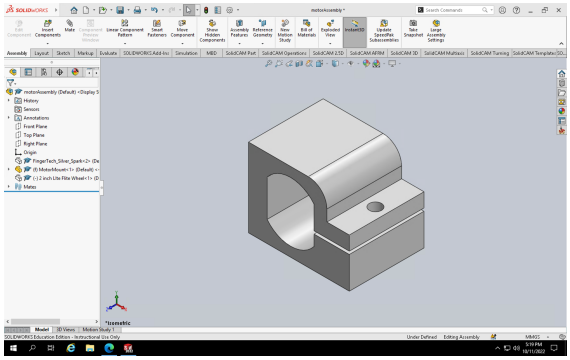
From there, they assigned us to create the motor mount and wheel assembly, using some pre-made parts which were provided to us by the instructors on Bruinlearn. These CAD models are parts we will be including in our actual designs, so we needed to do these models correctly.

Afterward, we met up with our teams to research current and past BattleBot designs and to come up with a rough idea of how we want our combat robot to look (chassis design, weapon choice, etc.). We have decided to create a box-shaped chassis with armor around the wheels and a horizontal blade for the weapon. In our next meeting, we will begin to create the K.I.S.S. (keep it simple and stupid) drawing for the idea we have in mind and, if we have time, begin CAD modeling the prototype.

Wheel Assembly



Motor Mount



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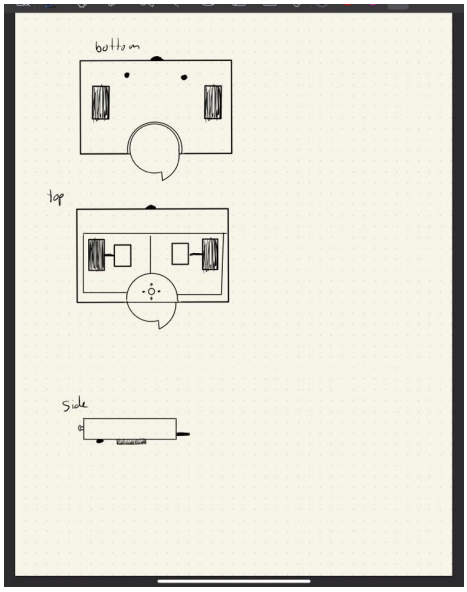
Entry Date: 10/ 14
Entered By: Erick Rosas

Notes:
When we met in class, the instructor went over Drivetrain and chassis design. The instructors gave us recommendations on weapon designs, like what works and what does not. They also gave us recommendations on what materials we should use and what we should avoid (acrylic). We did some practice CAD exercises in class, like building a motor mount and adding wheels to it. This was cool because we have to include that in our robot design so the practice applied to what we needed.
I and Victor began to discuss some possible designs for our robot. We went for more of a tank-like build where we would have a horizontal spinner. We hope to make it strong with the spinner coming out of the bottom of it. From what we had discussed, I created a KISS (keep it stupid simple) model.



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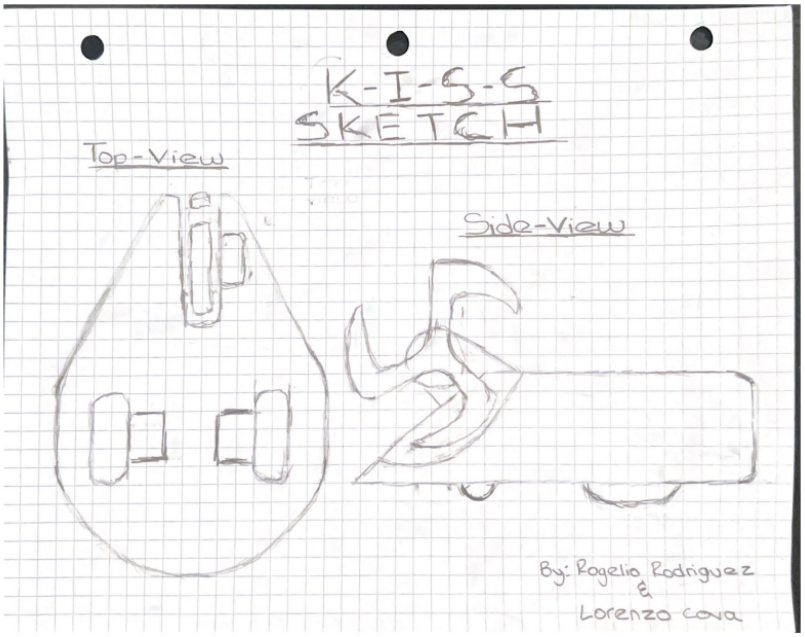
Entry Date: 10/13
Entered By: Lorenzo Cova

Notes: During this week's class we learned about the numerous components that go into the robot we will design. We need to consider and decide on a drive train, weapon mount, and chassis for our robot. We learned that we will have the two-wheel drive and one weapon motor available for robot construction and that we need to keep the robot body as light as possible. Rogelio and I began to decide that we want a vertical spinner weapon with wedges on the side after doing research. We wanted to emulate the weapon design of one of the most effective battle bots called BiteForce. We also learned that curved or chamfered edges are stronger than sharp edges so we will design a circular chassis that emulates the shape of the Millenium Falcon since it has a good design for a vertical spinner already. We will complete a simple sketch of the idea we have about the body and weapon.



Entry Date: 10/12

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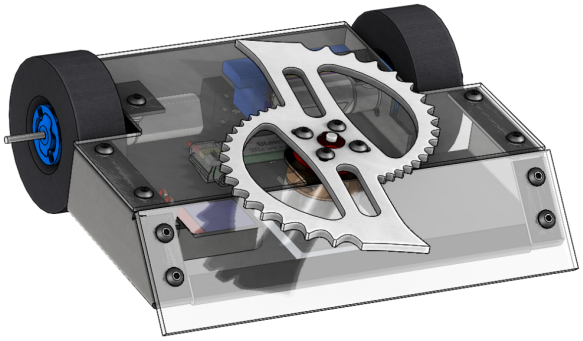
Entered By: Rogelio Rodriguez

Notes: This week's class focused on various types of combat robots, limiting us from wedge battle bots due to the simplicity of the weapon. From the start, Lorenzo and I knew we wanted a spinner robot, but were indecisive about whether the spinner would be horizontal or vertical. After analyzing the pros and cons of both types of spinners, we ultimately decided that our weapon would be a vertical spinner. Our research led us to various integrations to make our robot more susceptible to damage without resulting in losing the competition. One integration is adding screws to flat walls to prevent the robot from flipping over and ruling us out of the competition. Another integration we plan on is having an indirect weapon mount to prevent motor damage which can result in losing the functionality of the weapon. From our research we also learned curved or chamfered edges are stronger than sharp edges so we will design a circular chassis, taking inspiration from the millennium falcon. The reasoning behind this is filets help by distributing stress over a broader area, effectively making parts more durable/capable of bearing larger loads. The chassis also serves as a protective measure for the wheels, integrating the wheels inside the chassis.

Horizontal Spinner Example



Vertical Spinner Example

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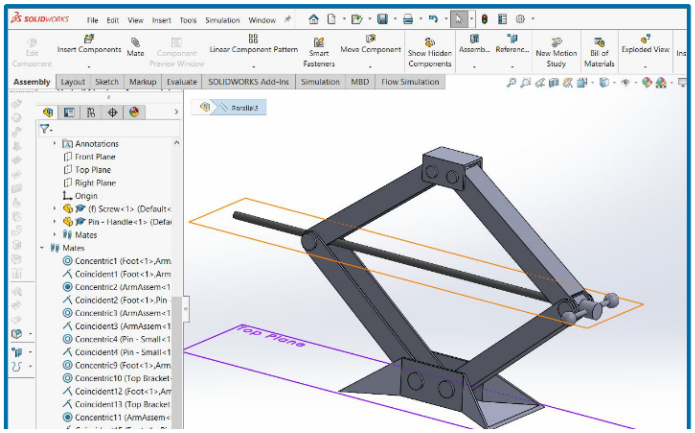
Week 4
Entry Date: 10/18
Entered By: Lorenzo Cova

Notes: During this week's class we learned about machining and 3D printing processes that would help us put together and work on our robots. We learned how different machinery has specific uses that would help us modify our robot parts and create exactly what we need for the robot. Then we learned about certain 3D design features that affect the printing of a part and how we should refine parts to get ready for printing successfully. We also learned about different factors that come with selecting a material type for chassis like resilience and density. We also saw previous class robots which convinced me to create an indirect motor mount with a pulley system so that the weapon does not break. Then we broke off into independent work and Rogelio and I worked on a CAD design assignment as well as talked about certain features we were certain about for the robot. We confirmed the weapon shape and type of mount, and that we want all motors to be protected in the chassis.

CAD Assembly Assignment

Step 14: Final Mates

- To get the movement we want, we need to constrain the top to be parallel to the base.
- The screw also has to be parallel to the base (use planes).



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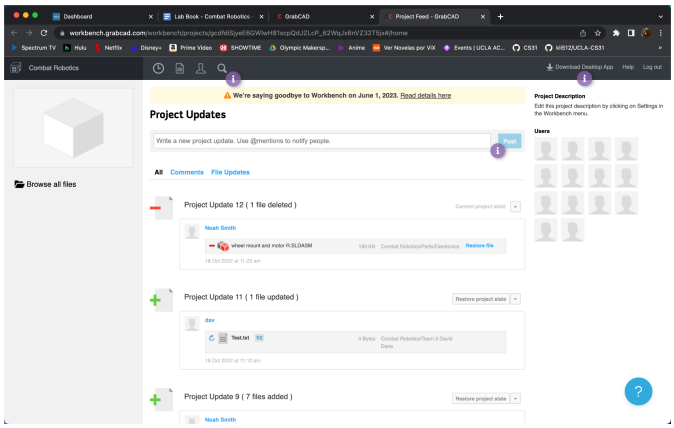
Entry Date: 10/18
Entered By: Erick Rosas

Notes: During this week's class, we went over the type of machines that are available in the Maker Space in Boelter. Victor and I discussed our robot design and made final decisions on the weapons, the materials, and the shape of our robot. Our chassis is going to be made of ABS plastic and we will 3D print that. We will use GrabCAD to make it easier to collaborate on creating the robot. When we toured Boelter's Maker Space, I and Victor agreed to complete the weapon CAD by Friday to go over it and make changes.

ABS Filament

GrabCAD Combat Robotics Workbench



Entry Date: 10/18
Entered By: Rogelio Rodriguez

Notes: This week as a class, we toured Bolters Maker Space and saw the available type of machines we have at our disposal to manufacture our robot. This week, we are primarily focusing on the weapon. The key components of the weapon are the moment of inertia. Overall increasing the moment of inertia, increases the moment amount of energy in the weapon, making it inflict more damage. Although increasing the moment of inertia conflicts more damage, the larger the moment of inertia results in taking the top weapon to spin up longer. This is an issue because the overall tactic we came up with to win the rounds was to flip them over while at the same time inflicting damage.

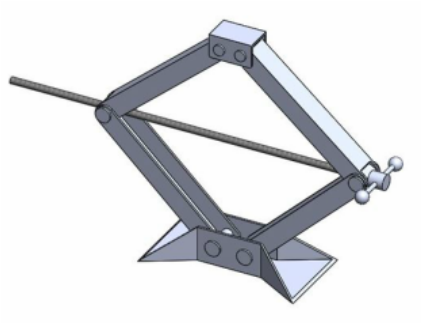
Rotational Kinetic Energy Given By

$$E = \frac{1}{2} I \omega^2$$

Entry Date: 10/18
Entered By: Victor Acuna

Notes: During this week's class, we went to MakerSpace to get a brief tour, as that is where we are going to manufacture our combat robots. From there, we went back to the classroom to begin working on the homework assignment, which was to assemble a Scissor Jack. After that, we set up GrabCad to share and collaborate on CAD files. Lastly, to end the class, we began discussing the CAD model for our robot. I am to do the CAD model of our robot's weapon before the end of the week. We are also to work on the CAD model of the chassis for our combat robot this week.

Scissor Jack Assembly

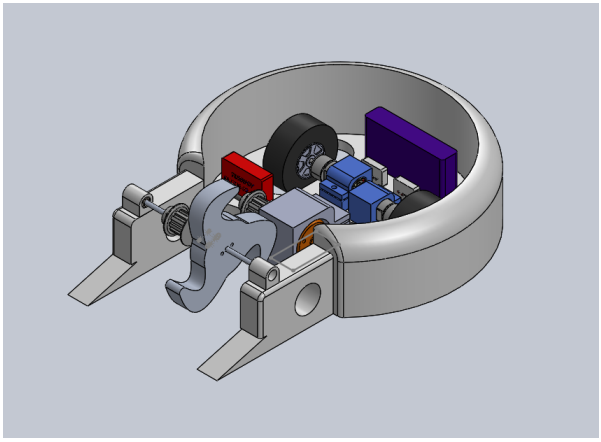


Week 5
Entry Date: 10/25/22
Entered By: Lorenzo Cova

Notes: This week we looked at the plan for the final competition and tips they gave us such as printing extra parts for quick repair. I took note of the biggest worries we should have about the competition such as wires coming loose, motor/batteries being poorly mounted, fasteners breaking, and wheels becoming damaged preventing movement. I noted that we should aim for as much weight as possible without going over, approximately 1.150 is a great weight to shoot for. We then looked at example bots that do not work and important details were: mounting motors correctly, making the robot guts accessible, giving space between wheel motors for electronics, and positioning weapons ideally. The rest of the class and the week we worked on

the first design of our robot complete with all requirements to be reviewed by mentors next week. Rogelio and I put together a decent prototype of the robot we had envisioned.

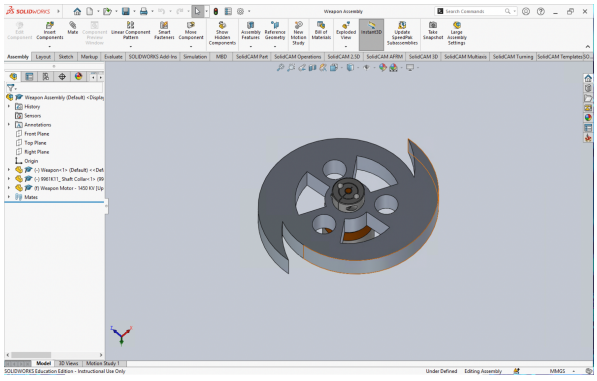
Isometric View of our Millenium Falcon Robot

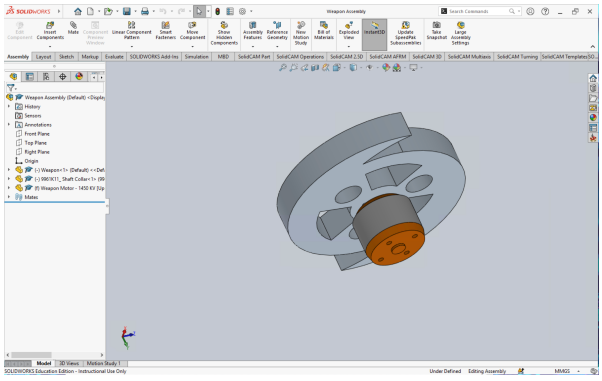


Entry Date: 10/25/2022
Entered By: Victor Acuna

Notes: This week, we finished creating our weapon CAD model and began to do the CAD assembly that shows the weapon attached to the motor. Our gun looks a bit different from what we had on the KISS model. We have now added 2 sharp ends to the weapon as opposed to 1 to inflict more damage on the opponents. From there, we began to work on the CAD model for the chassis as they want us to start 3D printing next week. Being that we will be having everything done by this week, Erick and I will be doing the complete assembly of our combat robot by the end of this week as well. During a quick meeting between Erick and me, we agreed to secure the wiring inside of our robot once we begin building it to prevent the wires from disconnecting during the competition. The material we will use to secure them in place is still to be determined, however, we are leaning towards Velcro.

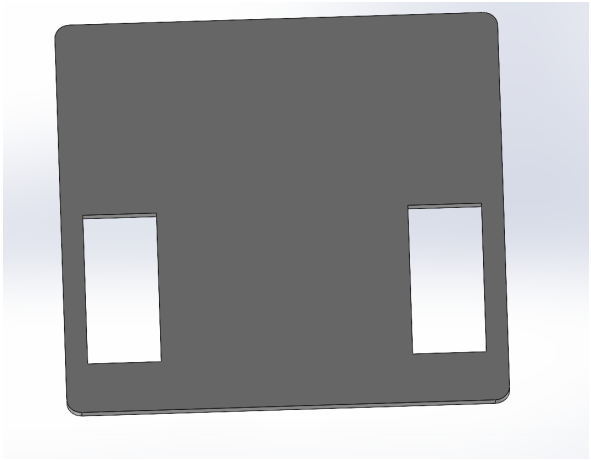
Weapon Assembly





Entry Date: 10/25/2022
Entered By: Erick Rosas

Notes:
During the lecture, the students were giving us tips on what common issues people face when they build a robot. They emphasized that the 3D printers were not 100% accurate, so they told us to expect the sizing for some of our parts to not be what we envisioned. They let us know if we wanted extra pieces we should order then. I and Victor agreed to add a ball stud on the bottom for added support for the robot since we decided only on a two-wheel robot. Also, if we get flipped, it will be somewhat reversible, so the wheels will come out both at the top and bottom so we can continue to drive.



Entry Date: 10/25/2022
Entered By: Rogelio Rodriguez

During this week's lecture, we went over previous designs of Battlebots pointing out flaws. This was a perfect transition to what we will focus on this week which is to CAD the chassis of the bots by the next class. Our main goal was to get to the maximum weight as close as possible to have a stronger robot. We had to keep in mind that the CAD won't just be the chassis but other components: mounting motors, batteries, weapons, and wires. Throughout the week we chose to ignore the weight until we finalized the prototype build until we ran into a dilemma, we managed to go overweight by a whole pound! We resulted into using the cheese method. The cheese method is cutting holes into an object to reduce the overall weight. Unfortunately, to our best effort we couldn't manage to get the bot underweight so next week Lonzo and I will focus on meeting with the instructors to find alternatives apart from the cheese concept to meet with weight constraints.

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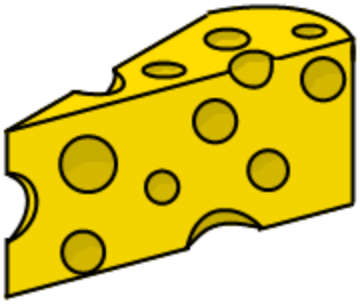
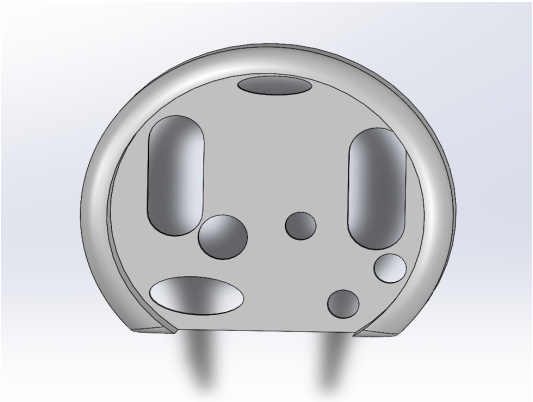
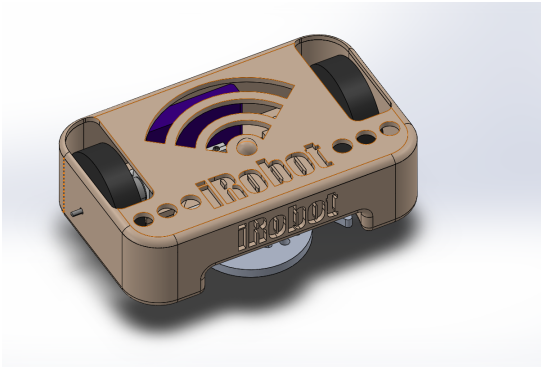




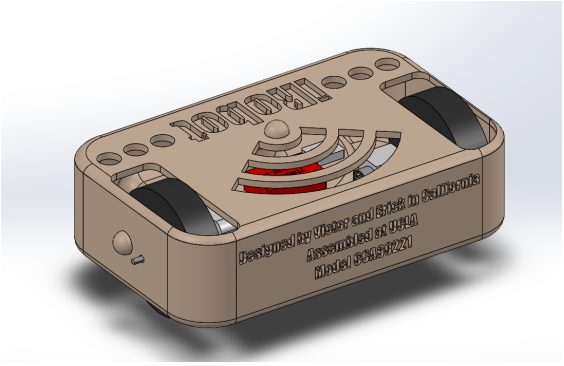
Week 6
Entry Date: 11/2/2022
Entered By: Victor Acuna

Notes: Throughout the weekend, Erick and I have been working on the complete CAD model of our combat robot. I worked on the chassis, including the top and bottom chassis, while Erick worked on the assembly of all the past parts we did. On the chassis, I have added the name of our robot, iRobot, around the chassis and have also added some holes around the chassis to allow for the robot to be lighter overall. I have also added spheres on the top and bottom to prevent the robot from being uneven and leaning over. Next week, we will be 3D printing our CAD models and hopefully, putting together iRobot.

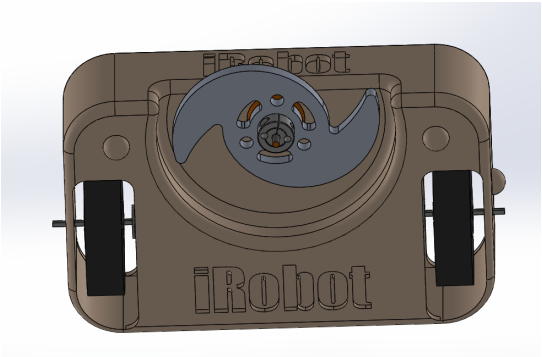
Front View



Back View

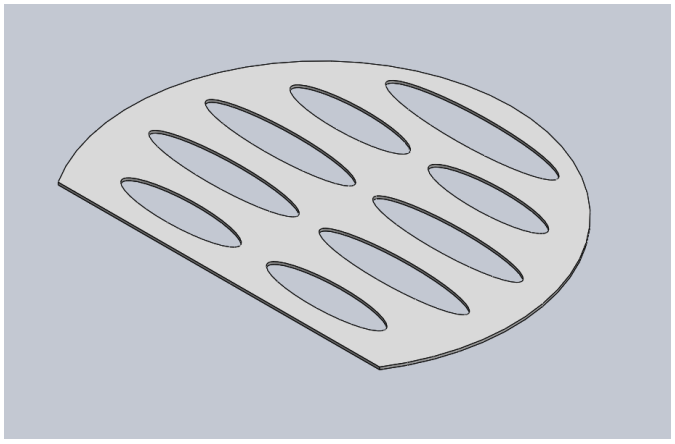


Bottom View



Entry Date:11/1/22
Entered By: Lorenzo Cova

Notes: This week we got lots of feedback from our instructors on our robot design. We took notes on all the changes we should make which included securing a stronger weapon mount and decreasing chassis thickness to meet the weight goal. Rogelio and I began right away to make design modifications and order specific parts that we needed for the pulley mounting system. We were able to create a very stable weapon mount compared to the previous one and shave off a lot of weight by reducing wall/floor thickness and chassis size. We were pretty confident with the design we had now because the body was all a solid piece that included a good mount for the weapon. We began to think of the lid we should design and we came up with a really thin and bare minimum lid to limit weight. Below is the lid we designed for our current prototype.



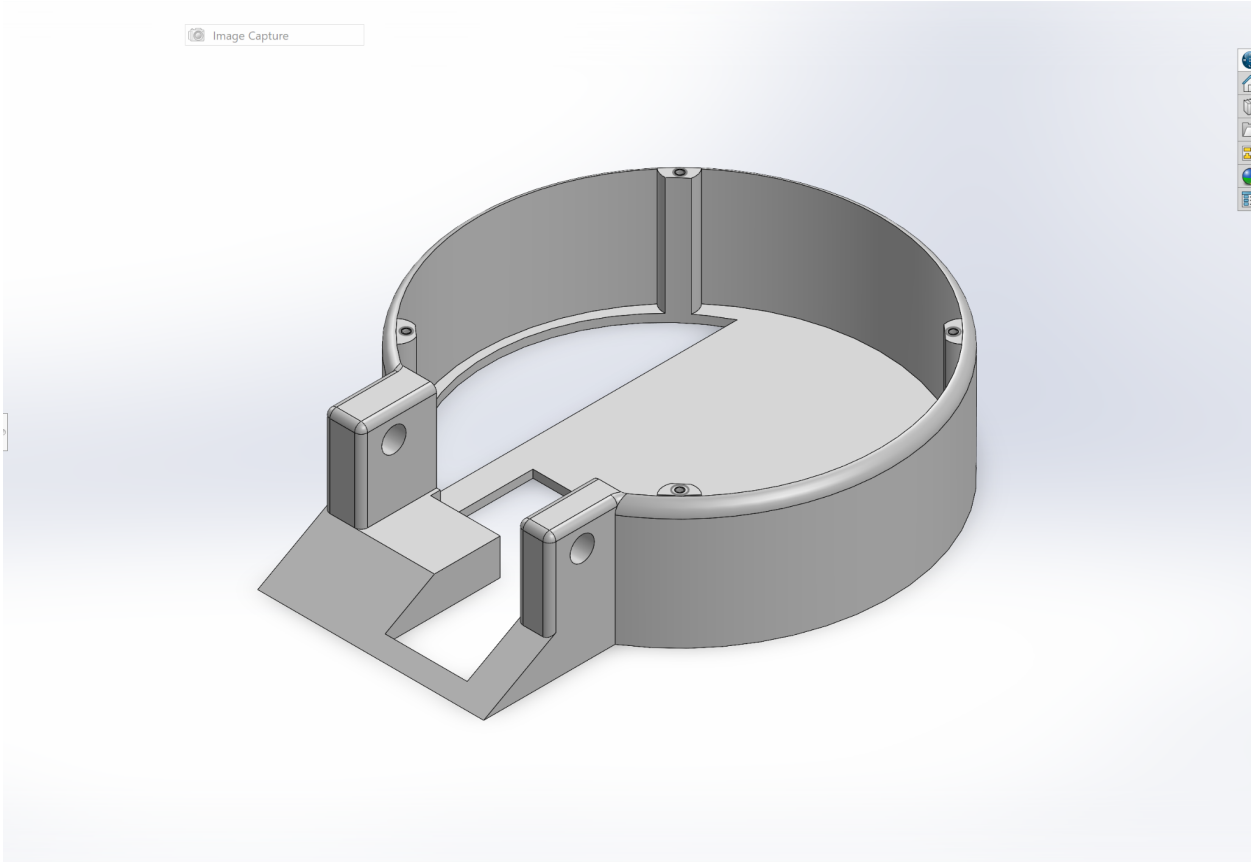
Entry Date: 11/3
Entered By: Rogelio Rodriguez

Notes: This week we met with the instructors to get valuable feedback for our robot to abide by the weight guidelines. Last week, we were aware that our CAD model went over the weight

restriction so before meeting one-on-one with the instructors we would have to make changes to our model. After meeting with the instructors, we came up with these alternatives to slim down the overall weight of the bot:

- Lower the wall thickness
- Find another way to mount the weapon motor
- Make the floor thinner 0.08”
- MAKE CHASSIS SMALLER 🙁

After consulting with Lorenzo we worked on modifying the initial model and came up with our second prototype.



Entry Date: 11/3
Entered By: Erick Rosas

Notes:
I went down to the maker space in Boelter to print the chassis and the motor mounts. I had to create an STL file to be able to print it in the Prusa printer. The first time I created it, I decided to add a brim, it made the pieces extremely difficult to work with and overall, I had to reprint everything. The second time I got it printed, the lid and the motor mounts were fine, however, the chassis had a couple of problems. The hole for the weapon motor was too small and there was nowhere for the wires to go. Victor got it fixed, and then I got it printed for the second time. I then started the electronics but I ran into multiple problems.

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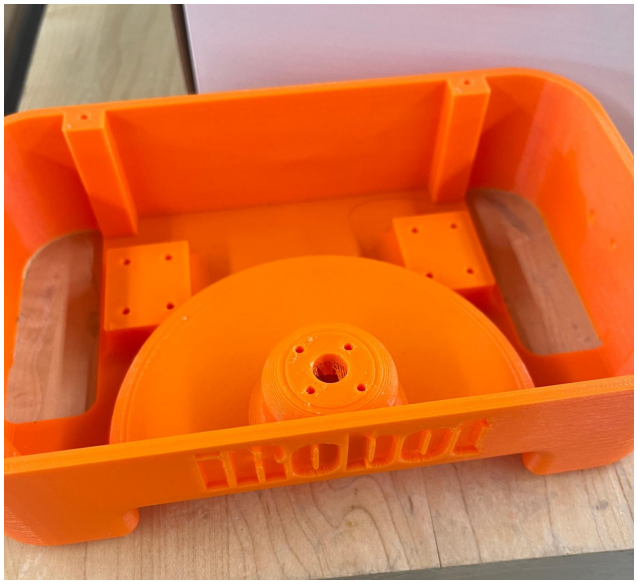


Week 7
Entry Date: 11/9/22
Entered By: Rogelio Rodriguez

Notes: This week we focused on the electronics portion of the project, learning the fundamentals of soldering and safety of course. Once the overview was completed we began to focus on the electronics for our bots. In class, we worked on soldering the power to the switch, and that led to the resistor in parallel series which would cause an issue later on. For homework, we were assigned to connect the drive ESC to the motor, the weapon motor to the ESC, and the power to everything else. To make sure all the connections were made properly, we went to the office hours to test the electronics which led to a discovery. Our electronics wouldn't respond although the led would flash blue, the ESCs would flicker, the controller was connected to the circuit but wasn't responsive and the receiver wasn't signaling power. After observing the electronics we noticed that the ESC's were flickering but dimly, while the LED was bright which led us to determine that the parallel series was draining most of the power from the w1hole component. We changed the parallel circuit into a series circuit which allowed the flow of the power to go throughout the electronics and made it responsive to the commands given by the controller.

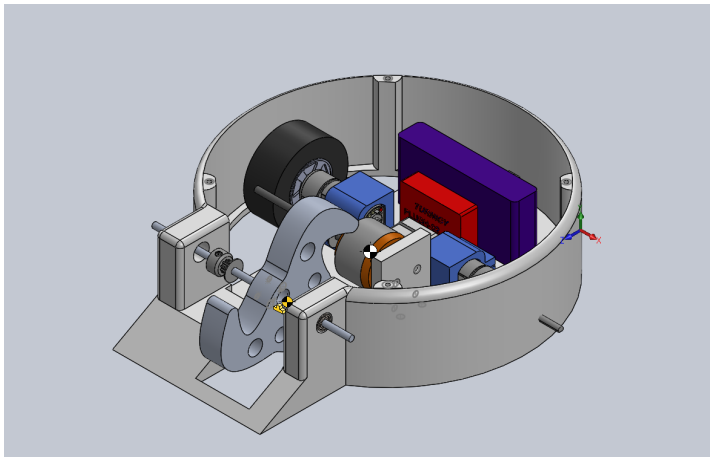
Entry Date: 11/10
Entered By: Victor Acuna

Notes: This week, we got to solder our electronic components together as well as using heat shrink to make the connections stronger. I have already learned how to solder in the past, but for Erick, it was a new experience, so I let him do most of the soldering. From there, I began to update the chassis 3D model as it had some issues when printing. I made the hole on the chassis for the weapon motor bigger, in terms of circumference, as the size it was before was too small. It was preventing it from spinning, so we had to change that. Erick will go on and print the parts this week to begin assembling the components.

Entry Date: 11/10
Entered By: Lorenzo Cova

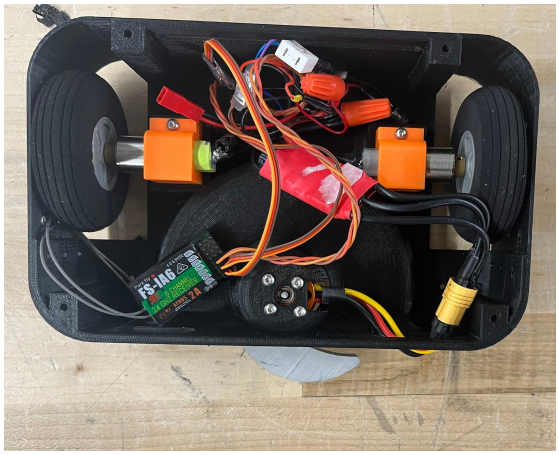
Notes: This week we were able to print the chassis and motor mounts we designed and test the actual weight of the whole bot. We saw that the body was much too heavy and our instructors advised us to scale down the chassis design. We also had to work on the electronics for the bot as we learned how to solder everything together. I focused on rescaling the chassis in CAD as well as adding important features for protection like screw holes for the lid. Meanwhile, Rogelio focused on finishing the electronics for the robot. We then started to assemble the bot by figuring out how to secure everything in the correct spot for the robot. We found that because of

rescaling, the weapon pulley system was affected because of the distance change. We hope to figure everything out in class when we are given the remaining parts we need as well as the wheels. Here is a photo of the redesign of the bot and the rescaling:



Entry Date: 11/14
Entered By: Erick Rosas

Notes: This week we received all the electronics we need to start soldering and connecting them together. Victor and I did some soldering in class, but the LED light was not turning on when we tested the electronics. We ran out of time during class, and we had no idea what we did wrong so I went to the office hours for help. I had to melt the solder off, to disconnect the wires to see what was wrong. After I was done with the soldering, I had broken the LED light, so I had to do it all again. In the end, I left with my electronics finished. The new chassis was also started to be printed.



Week 8

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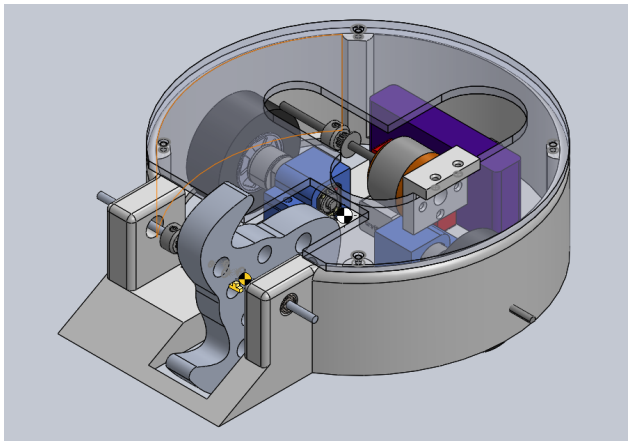
Entry Date: 11/17/22
Entered By: Lorenzo Cova

Notes: This week we received all the parts we needed and worked on getting the robot to drive as soon as possible. In class, we spent the whole time trying to figure out how to mount the drive motor mounts to the chassis because there were no holes added in CAD since we didn't know how the parts would actually fit. We were able to melt brass inserts into the motor mounts and attach one motor mount to the chassis. Through office hours we finished attaching the other motor mount and our robot turned out to drive very well. We continued to assemble the weapon system from front to back in order to see where we needed to mount the weapon motor. We also redesigned the lid to fit the new chassis size and screwed it onto it. Latest and final CAD design we produced:



Entry Date: 11/19/22
Entered By: Rogelio Rodriguez
Notes: This week we focused on assembling the robot because the parts we had ordered to assemble the indirect weapon mount had arrived. We came to the realization that the band we initially had ordered was originally ordered for a larger chassis, which wasn't the case now due to resizing the chassis to accommodate the weight restrictions. This issue was that the wheel motor mount took up space for the weapon motor mount to be placed for the pulley system to function. After a lot of thinking, we came up with the idea of mounting the weapon mount off of the roof. In order to do this, I redesigned the weapon motor mount to be smaller so it wouldn't interfere with the electronics or the wheel motor mount. As well as not only adding an opening on the roof for the mount to be added but in order for the weapon motor, timing pulley, and rod to fit and be functional.

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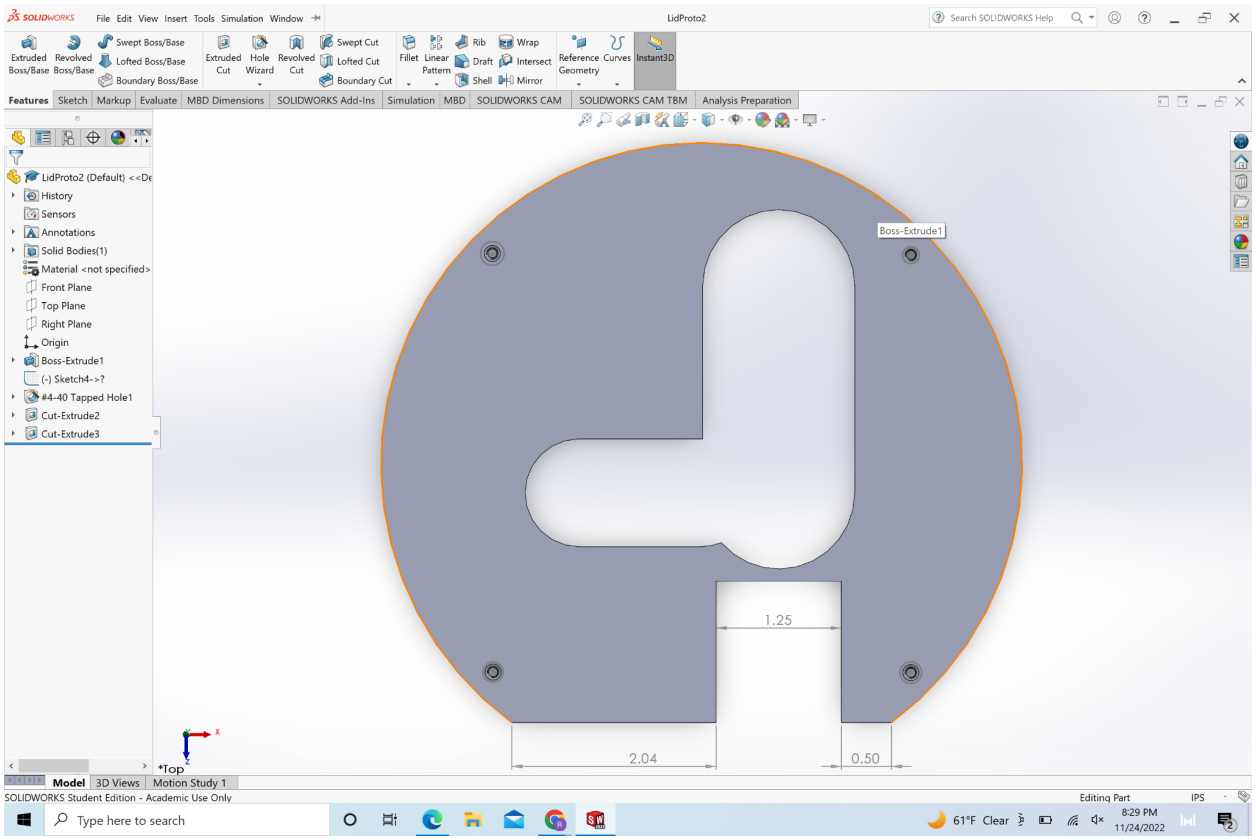

Entry Date: 11/ 20/22
Entered By: Erick Rosas Gonzalez

Notes:
We finally got our battery this week to do some test driving. However, when we plugged it into our battery, the electronics sparked and then started a small fire. This also meant that I had to redo all of our electronics. The student teaching the class felt bad because she told me how to solder and did not see anything wrong. Also this week, our chassis was done building. We had a couple of issues with the chassis. When we tried to remove the fill-in material from the back, it refused to come out, making it look bad. Also, the wheels hit the sides of the chassis, so we had to make it a little larger.

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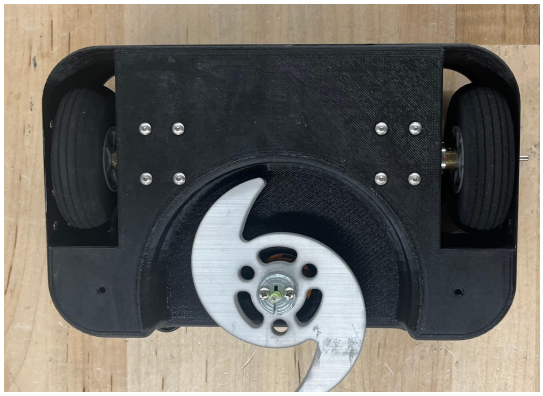
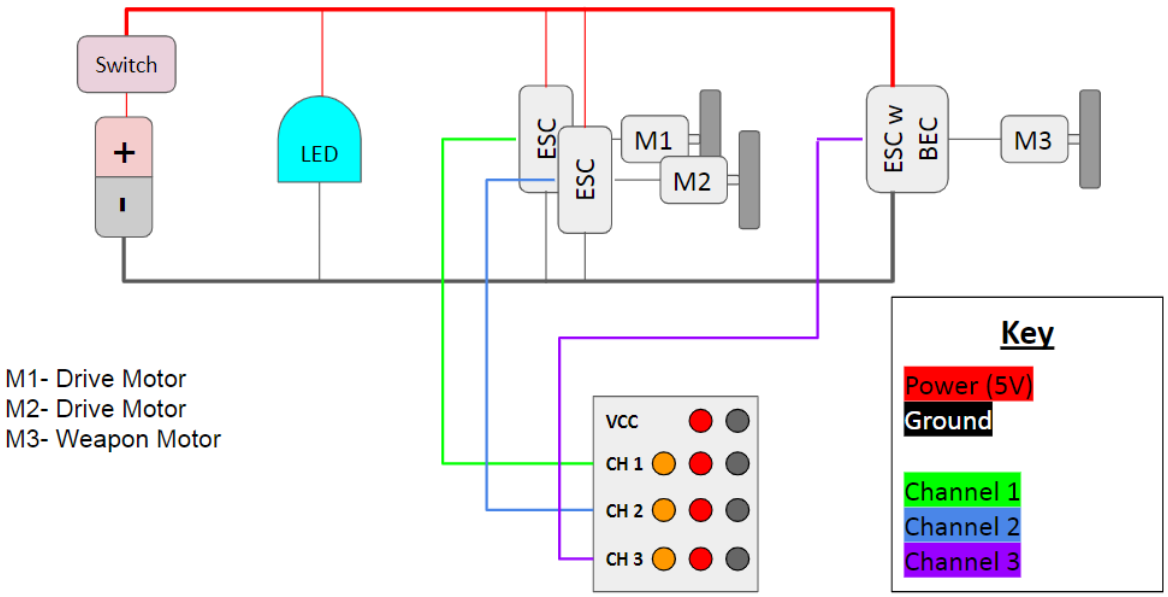


Entry Date: 11/20/22
Entered By: Victor Acuna

Notes:
We got the parts needed to fully assemble today. As we were going to assemble the parts, Erick connected the battery, which caused a small fire. This resulted in our parts frying so the electronics had to be redone. We had to go during office hours to redo the wiring. It turned out that the schematics they provided for us were wrong, so the TAs had to redo the electronics for everybody. We were supposed to test drive our bot today, but given this problem, it will be pushed back to next week. We do not have the old schematics that were wrong, unfortunately, but we do have the new schematics, which will be provided below. I also have to edit the 3D model as the back words were too small to print out, so I will change that. I will also make the chassis wider as the wheels are touching the walls.



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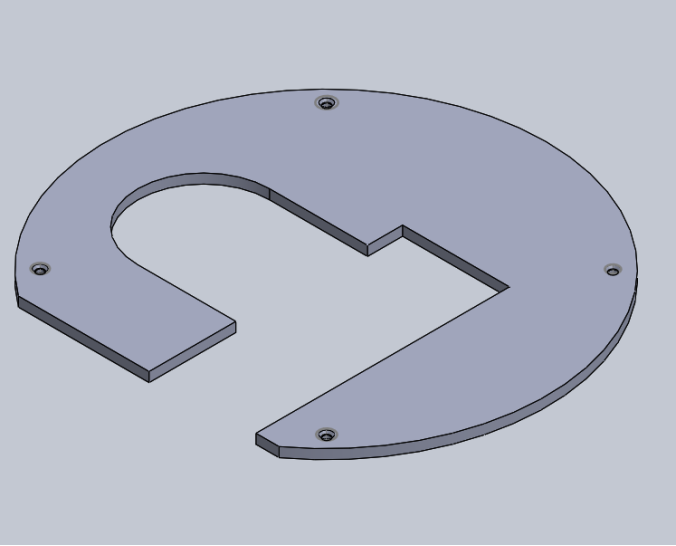
Week 9

Entry Date: 11/22/22
Entered By: Lorenzo Cova
Notes: This week we presented our projects to the rest of the class with a quick slideshow of the key features of our bot. In this slideshow, we included images of our design process, weapon assembly, and specs of our robot. We measured the robot dimensions, and weight, and discussed the indirect motor mounting for the weapon that we designed. We also explained the inspiration for the name “Black Panther” which comes from our weapon emulating his claws. We elaborated on what we learned throughout the project and its process such as resizing the chassis in the future, raising the weapon rod location, and adding aluminum armor. We did some driving practice with our robot and I started to get used to the controls of the robot driving for the competition. The robot drove very well according to our instructors. Other than that we continued to finalize the assembly of the robot and we set the lid and motor mount to print. We put together the weapon assembly and it worked, however, we needed to modify the lid one last time so we reprinted that again. Here is an image of the finalized lid design:

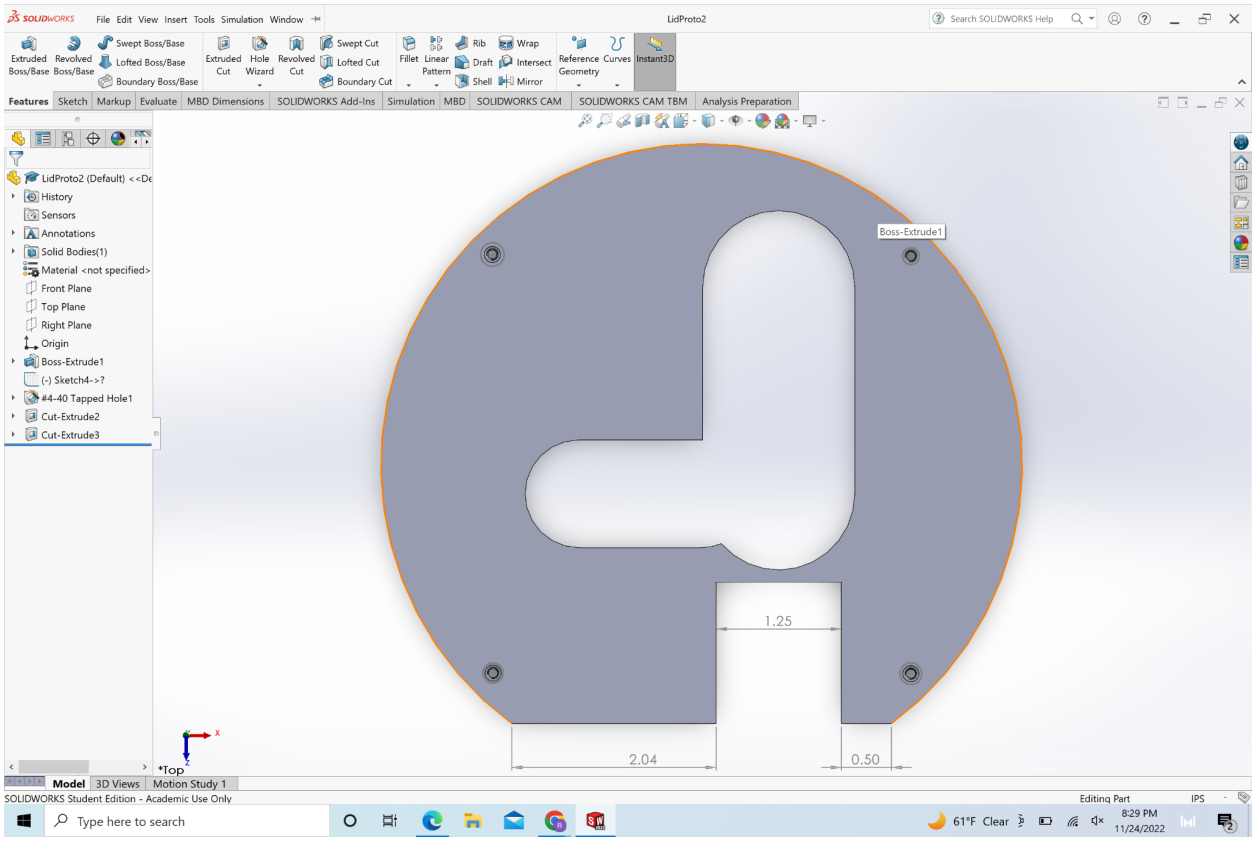


Entry Date: 11/23/22
Entered By: Rogelio Rodriguez

Notes: With the competition being next week, we focused on finalizing everything on the robot. We took the robot to the cage to drive around, practicing for the competition. We came to the realization that our weapon would drag which can essentially cost us from winning due to it more than likely going to flip us into the air or breaking our indirect motor mount system. In order to avoid this me and Lorenzo added a screw at the front of the wedge in order to give the weapon enough clearance from the ground. In doing so, our initial tactic of flinging robots into the air may not work if the wedge isn’t low enough to ramp the opponent into our weapon. Another flaw was our lid, because the lid's ends had curves it affected the mounting of the motor mount because we couldn't straighten the band because it couldn’t reach the timing pulley. We

modified the lid to be straight which would allow the mount to be mounted and make our indirect mount a success. This would take longer than expected due to our print failing because of the 3D printer breaking and the maker space forgetting to reprint our lid and making us wait in a queue. This would add suspense to our week due to both Lorenzo and I leaving home this Wednesday for the break.

Initial design:



Final Design:

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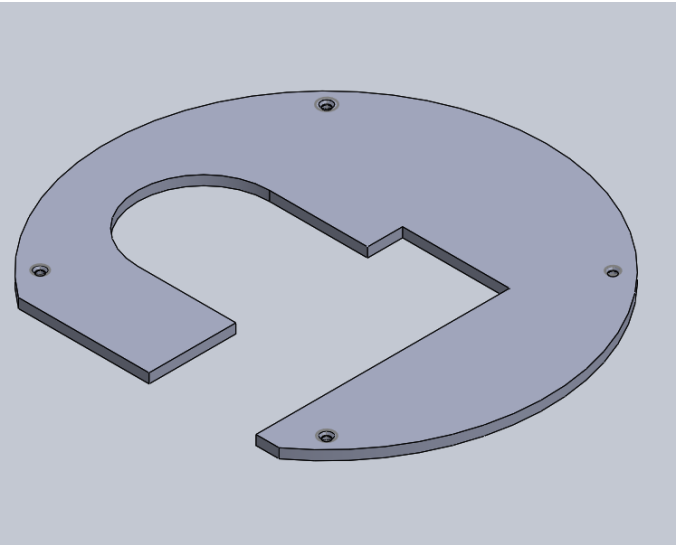
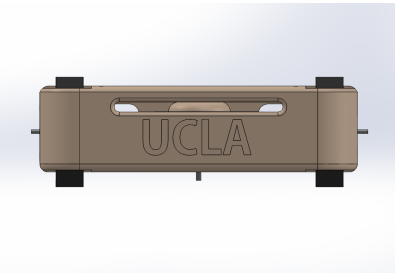


Entry Date: 11/23/22
Entered By: Victor Acuna

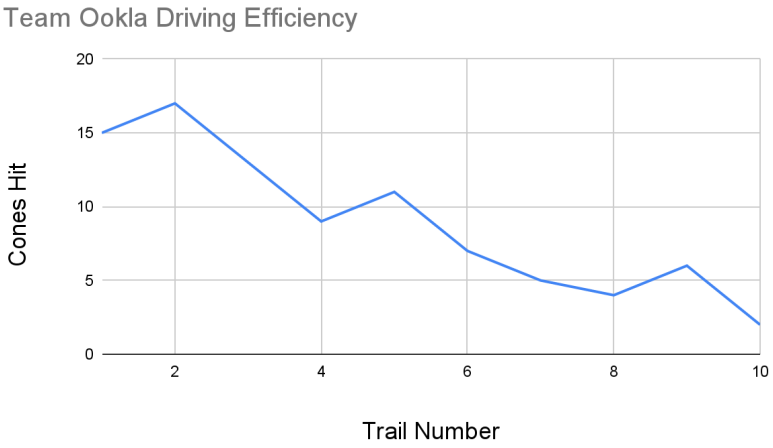
Notes:
I have now updated the 3D model, and it came out amazing! I have added more holes to make it lighter. The words on the back came out good now and the wheels no longer touch the walls. We assembled it together and took it out for a test drive at the arena. It was a maze-type area where we had to drive to the other side of the maze without hitting any cones. We hit a lot of cones at first, but over time, we managed to hit fewer cones. We knew we were getting good at controlling the robot when we were hitting fewer cones than before. We did a total of 10 trials. After the trials, we decided to see if the weapon motor worked. It did not spin. Erick will be going to the office hours to see what the issue is.

Before

After



Data We Got From Test Driving In The Arena
**** The fewer cones we hit the better ****



Entry Date: 11/23/22
Entered By: Erick Rosas Gonzalez

Notes:
Our final chassis was done printing, so we finished assembling the robot. We finally did some test driving and the bot seemed to drive perfectly. However, the weapon did not want to spin at all. We spent the whole time in class trying to figure out why the weapon did not spin. When we went to office hours, I re-soldered everything and the weapon still refused to spin at all. Then, I tried to use different pieces, thinking one of our electronics had broken, but it still did not work. I tested the weapon outside the robot, and it worked perfectly fine, so the problem was something within the robot. We eventually figured out that the screws we used to hold the weapon were rubbing against the weapon motor, causing it not to spin. The final robot spun and drove perfectly.