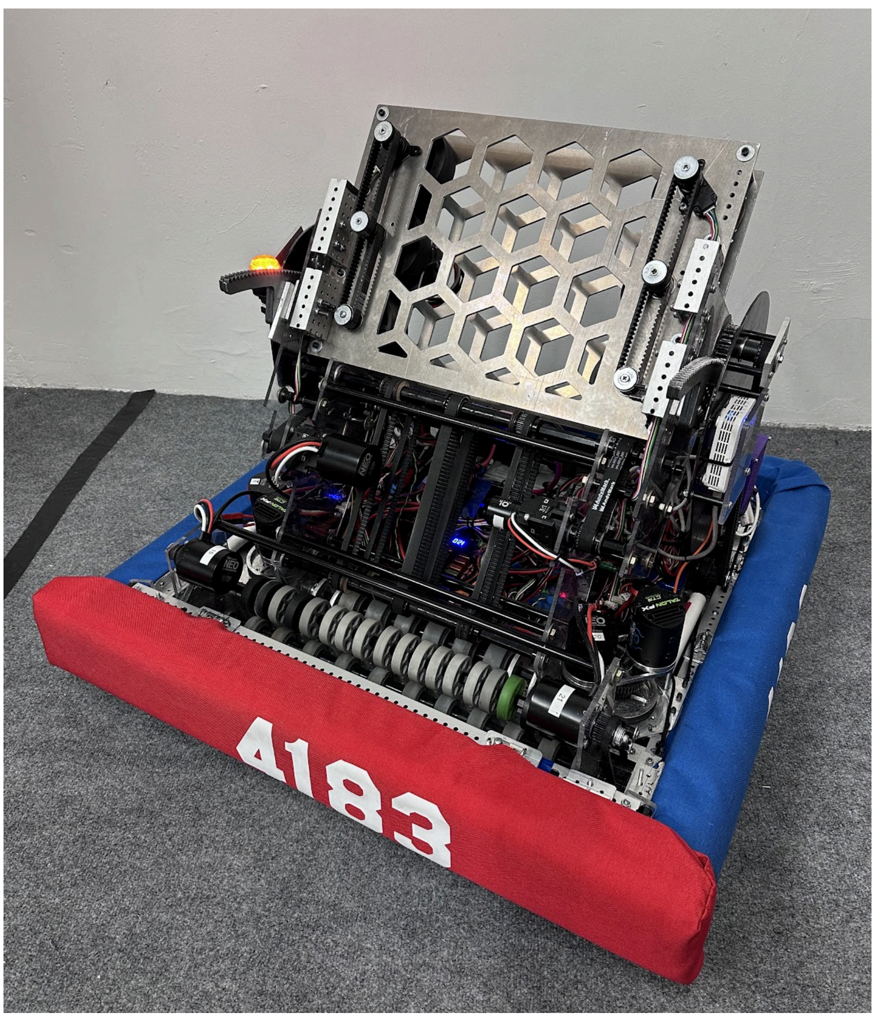
2024 Crescendo Technical Notebook
Bit Buckets Robotics FRC Team #4183



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Analysis of Crescendo:

After having our own kickoff at the Tucson Texas Instruments (one of our sponsors) building, members spent time reading through the manual, writing their own personal summaries, and answering questions.

Going through a worksheet, the members answered questions to become familiar with the game manual and rules. After going over the worksheet, we discussed as a team the strategy that we would like to do this year, along with finalizing our team and robot goals.

For our team goals this build season, we have ranked these five general season goals:

1. Winning a regional as captain or first pick
2. Make it to worlds
3. Engineering experience
4. Win engineering award
5. Building a cool mechanism - creative/unique mechanisms, don't over engineer

After considering these general team goals, we also considered our robot goals, and ranked these goals:

1. Low CoG
2. Reliable mechanism
3. Efficient
4. Vision
5. Repairable (modular, accessible components)
6. Clean wiring
7. Accessible electronics and battery
8. Small frame perimeter (petite)
9. Easily exchangeable bumpers
10. Robust
11. LEDs
12. Very beautiful/elegant
13. Very powerful

For our strategy, we then figured out what we want to do this year by figuring out our priorities. After discussion of ranking in difficulty and importance, we found these priorities and difficulty rankings:

Strategy ranking:

Things that we can do:	**Importance 1(most)-5(least)**	**Difficulty 1(easy)-5(hard)**
Mobility	1	1-2
Speaker (shooter)	2-3	3-4
Amp	2-3	2-3
Climb	2	3-4
Trap	3	4
Ground intake	1-2	3
Source intake	3	1-2
Vision	2	4

After the priority ranking, we decided on this final strategy. We would like to go for ground intake and speaker. Then we would also like to go for amp, and climb. The trap would also be a nice addition later if we can.

Initially, we figured that the strategy would be very different from match to match. Depending on our robot's capabilities, we also found that the strategy would depend on what our teammates can do. Some strategies we looked into included if a robot could do amp, we could have them cycle amp while the rest are scoring speaker. Additionally, we figured that with part of our match strategy to lower cycle times, we would like a consistent ground intake that would mean we wouldn't have to go fully to the source to get another game piece.

After our first competition at the Utah Regional, and watching some other regional competitions, we realized the importance for most alliances to have three offensive robots, and although defense can be effective, amplifying the speaker shots is very useful. Additionally, based on data and observation, we found that the auto points are very valuable since a single speaker shot is five points. This pushed us to focus on getting a better consistent auto routine.

Overall the strategy is to focus on speaker with a strong auto and ground intake.

Robot Overview:

Drive base:

- 28 by 27 inches
- MK4 Swerve
    - Kraken drive motors
    - NEO steer motors

Intake:

- Under the bumper
- Mix of colson, sushi rollers, compliant wheels, PVC
- NEO motors

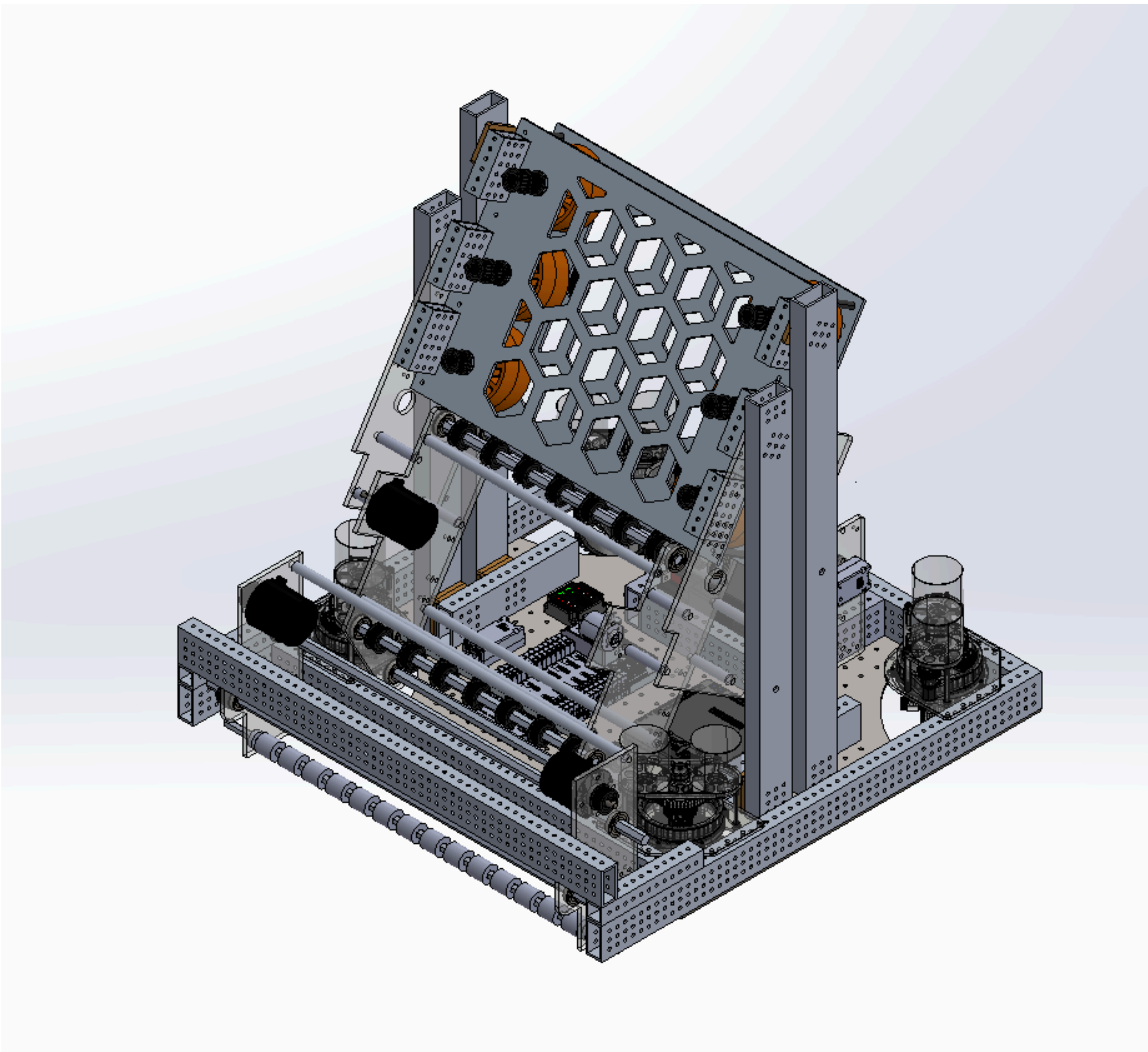
NMS (Note Management System):

- Beam break sensor!
- Belts on top and bottom
- NEO and NEO550 motors

Shooter:

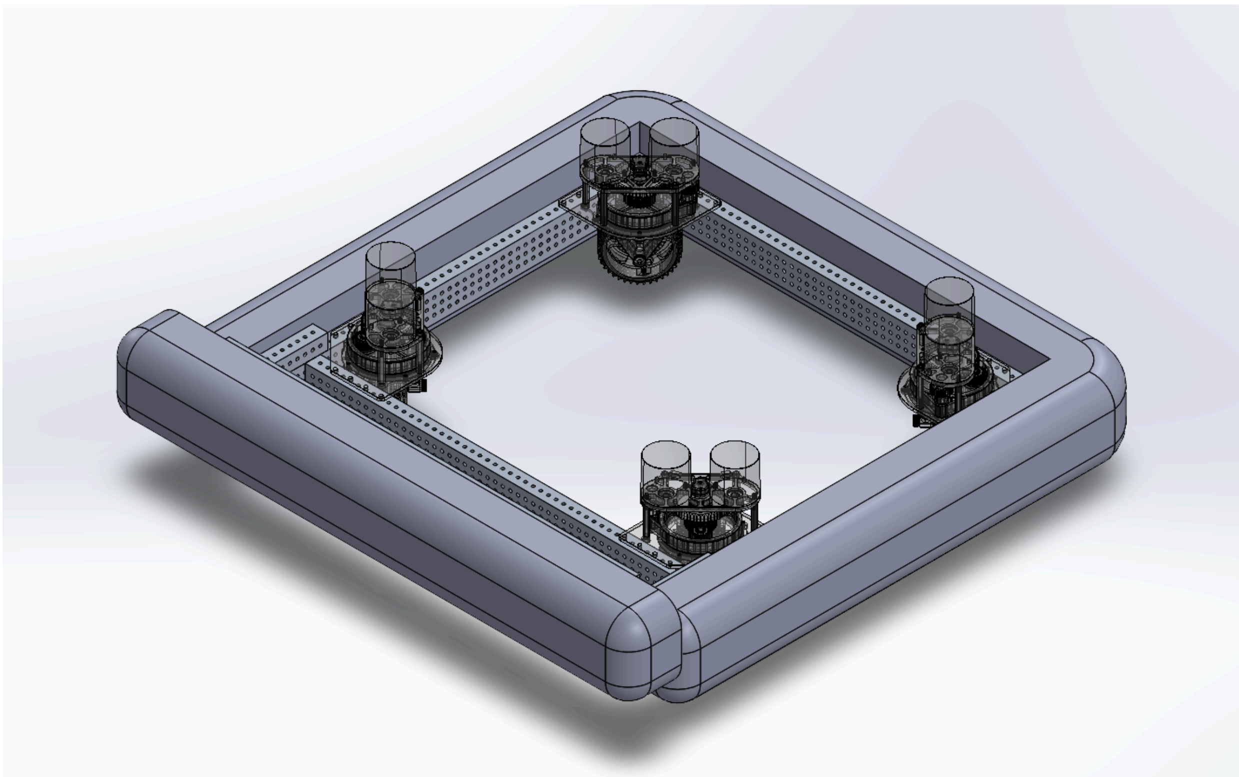
- 3in compression
- Mix of flywheel and compliant wheels
- 3 sets of wheels on each side
- Kraken motors

CAD:



Drive Base:

CAD:



Design Process:

We have used swerve for the past 2 years (2022 and 2023), and this year, we decided to continue using it due to the easy maneuverability and manufacturing.

After figuring out the size that the intake needs, which was 5 inches in front, we decided on a 28 by 27 in frame perimeter to be close to a square and double the game piece length (14 inches) on each side.

We are also using Krakens as drive motors, and NEOs as steer motors. Originally, when building the drivebase, we only had NEOs until the Krakens arrived, and our software team did a wonderful job of implementing the new motors!

Problems + Solutions:

We are using MK4s instead of MKi4s because of our main constraint on the drive base: ground intake. With ground intake in front of the swerve modules, we wanted a tube that goes all the way through the swerve module to form our drive base frame. MKi4s don't allow that, hence, we are using MK4s this year.

Interesting facts:

We have 3D printed spacers in our tube to prevent the screws from bending the tubes. Additionally, our belly pan is made of 1/8in steel with a pattern of holes for wiring, which is laser cut!

Bumpers:

Design Process:

We decided to use latches this year out of convenience. From past years, we have used L-brackets with a screw and nut that hold the bumpers down. However, we found that it often was time consuming and the L-brackets overtime would wear and loosen.

This year, we also did split bumpers, one piece in front, and a “U” shape in the back. This was due to our ground intake design, and we wanted the GPs to go under the bumper. In the back, the “U” is also lower than the front to prevent GPs from getting stuck under our frame.

Problems + Solutions:

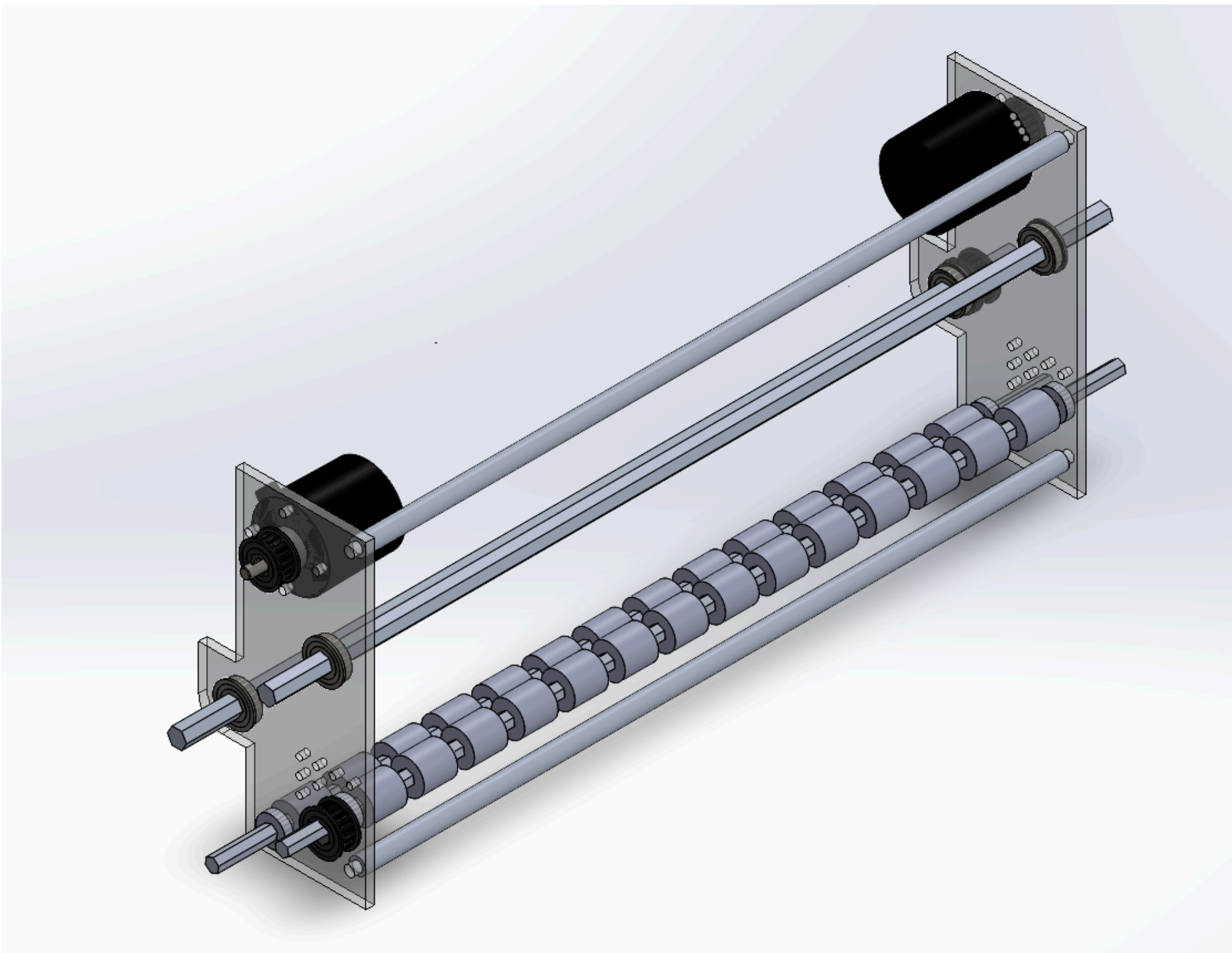
After attaching the latches and wood together, we noticed that the front part of the “U” bumper was bendable and floppy with side to side bending, so we added L brackets with a hole for a screw to line up with. This just prevents the floppiness of the bumpers. We did this on the front bumper as well. The front bumper also had additional polycarbonate additions to prevent up and down bending.

Interesting facts:

Some of our bumper numbers are ironed on, but some are painted on!

Intake:

CAD:



Design Process:

After trying different potential intakes, we decided on an under the bumper wheel-based intake.

The members first came up with these requirements:

1. Ground intake
2. Easily stowable
3. Efficient
4. Adaptable angles

5. Compatible with shooter
6. Can't damage notes
7. Wide area of contact

The mechanisms considered were: wheel intake under the bumper, wheel intake over the bumper, and piston claw intake.

Piston intake was prototyped, but we found that this was inefficient and we didn't have the right materials. The air pressure required to apply enough compression to the game piece was far too much to justify using pneumatics, and the claw was unable to hold onto game pieces well when faced with shaking or hits.

With the over-the-bumper intake, we preferred to protect our mechanism inside the frame perimeter, and we won't have to worry about getting inside other people's frame perimeter. Additionally, an over-the-bumper intake introduces more actuators, and we have learned from the past that reducing the number of actuators on the robot reduces the room for error. Further, an over-the-bumper intake would allow us to have a wider intake, as we aren't constrained to having the distance between our swerve modules be our maximum intake width. There are certainly ways to get around this (e.g. wheels that center the notes, perpendicular rollers to funnel notes in, etc) but we thought that the benefit of having a marginally wider intake was small in comparison to it being robust and compact.

Problems + Solutions:

One of the rollers bent too much when a game piece was inside the intake, causing it to flex into our robot's frame. This increased resistance caused the motors to draw too much current. We fixed this by sanding down the colson wheels so they just barely cleared the frame when bent.

After building and testing the intake, our biggest problem was having a wide area of contact for the intake without damaging the game piece. We couldn't intake the piece from multiple angles very well. After discussion and testing, we added at first front plates that prevented side entering at all. Later, we also considered ramps on the sides. Finally, after our first competition, we thought of adding static wheels lined up with the NMS on the inside of the intake, which allowed for a wider area of contact. For a few meetings we played around with different wheel orientations, and one of the biggest challenges we faced was finding a good layout for the rollers so that they cleared the main intake rollers (parallel with the ground). Eventually we tried using shafts with PVC as the rollers, as they had a smaller diameter and fit well within our constraints, this new approach worked very well and increased our area of contact by about an inch on each side of the intake.

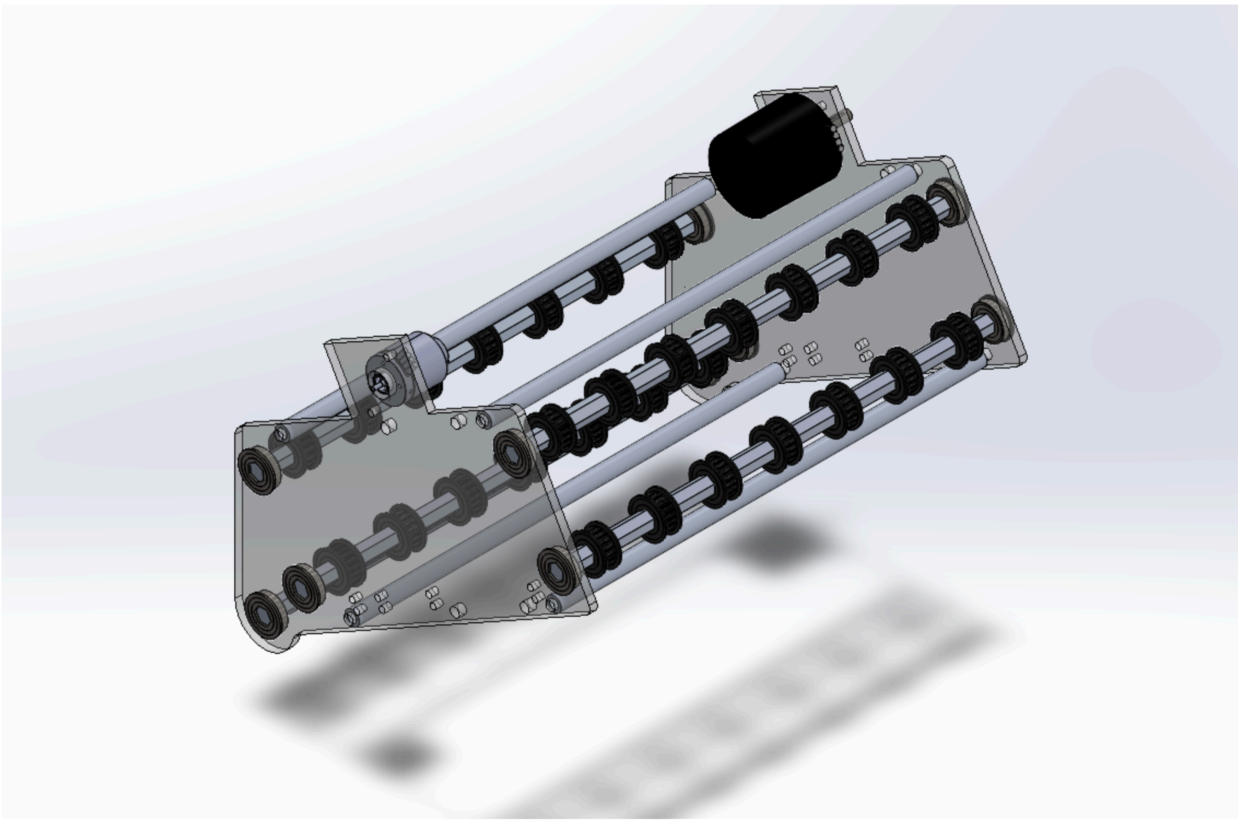
As we were conducting the final preparations for our second competition, we encountered issues with the top rollers drawing far too much current, and we spent hours trying to figure out what the source of excess friction was. After inspecting the intake for a while, we realized that two belts were running into each other, rubbing against each other as they both moved at high speeds. To fix this, we changed around the pulley setup, and made sure there was separation between the two belts, so that they wouldn't rub. This significantly improved our current draw issues.

Interesting facts:

The front top roller is just a PVC tube with grippy tape on it!

NMS (Note Management System):

CAD:



Design Process:

After finalizing most of the intake and the shooter, the NMS was designed as a note indexer between the two to allow for consistent speeds into the shooter.

We wanted the shooter at a height of around 22 or more inches from the ground based on testing, so the NMS length was determined based on that. We made sure that there was enough space for the game piece to rest right before the shooter flywheels, allowing the shooter wheels to get up to the ideal speed before the game piece is fed through.

We decided on using belts going over the top and bottom of the game piece for two main reasons: compression and accessibility. Having belts compress the game piece from the top and bottom makes for a more reliable handling of the game piece as it is passed from the intake to the shooter.

Problems + Solutions:

One of the problems we had with the belts was that the pulleys would damage the game pieces. We then decided to add wood spacers that spaced off the pulleys at a larger diameter, which prevented the metal from cutting up the pieces.

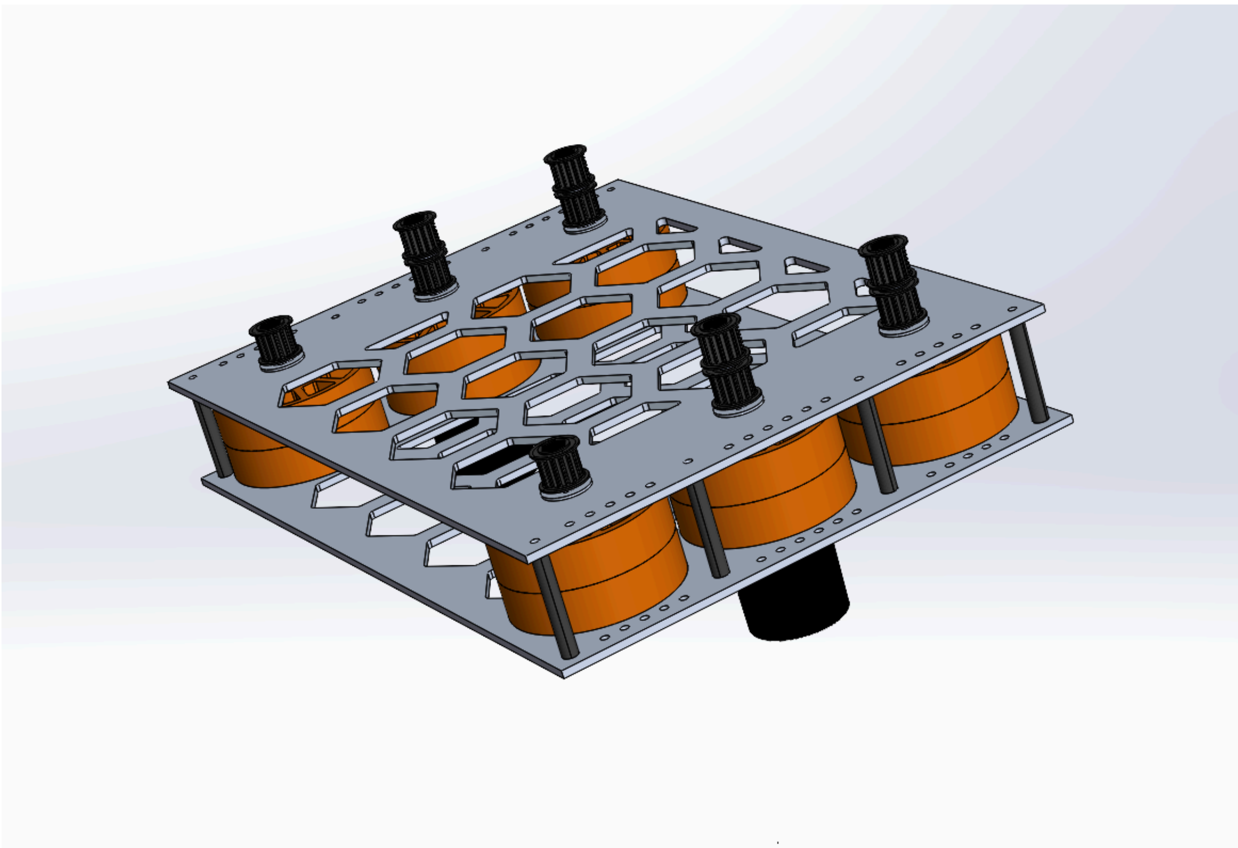
Another problem we had while designing was connecting the NMS and shooter. Since the shooter had plates on the top and bottom, but the NMS had left and right plates, we added a tube on top of the shooter, and then connection plates that connected to the NMS plates and the tube.

Interesting facts:

We have a beam break sensor in the NMS that allows us to know if we have a game piece in our NMS or not!

Shooter:

CAD:



Design Process:

After trying top and bottom wheeled shooters along with the side wheel shooter, we found the side wheel shooter worked best for us.

To start off, the main requirements of the shooter were the following:

1. Small shooter
2. Short shooter (to fit under stage)
3. Shoots at different angles
4. Variable speeds
5. Speaker shots
6. Amp shots

We prototyped different compressions and different wheels, and we ended up with flywheels and hard compression wheels with three on each side. We also found that the compression we wanted was around 3 inches.

When testing with the angles and distances, we found that up against the speaker, we wanted an angle of around 58 degrees.

Additionally, with lower gearing and flywheels, our shooter shoots very fast at the speaker.

Problems + Solutions:

When deciding the material for the shooter, we realized that it would be high up, but we didn't want a flexible material that could be influenced by vibrations. We decided to then go with 3/16 in thick aluminum that was laser cut.

When prototyping first began, we had issues with getting our notes up to reasonable speeds. We tried working with different gearings, lowering coefficients of friction, even thought about using different motors. After doing some research we realized that our problem might be note compression/wheel contact. A small group of mechanical students modified the original prototype such that it had variable compression, and after about an hour of testing we were able to find the optimal compression and began testing for angles, distances, and heights.

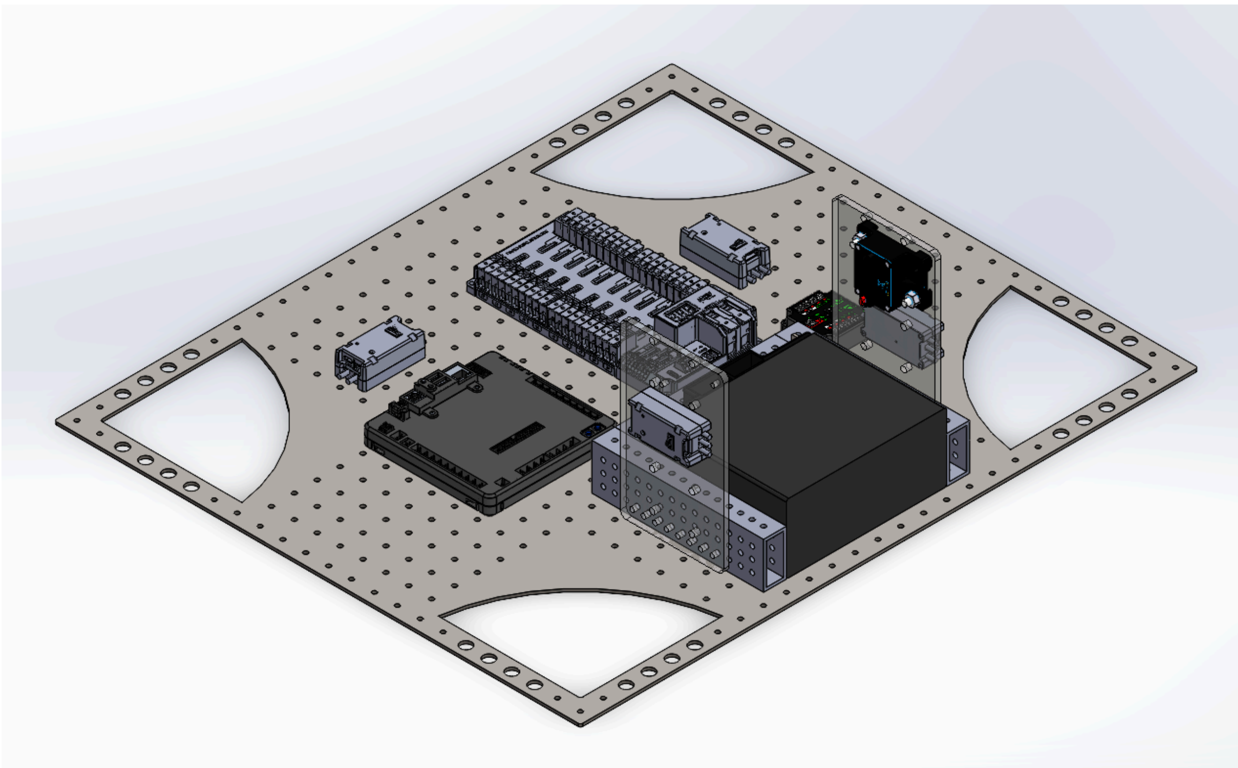
After our first competition, we realized that the variable angle pivot which we planned to use for shooting from various locations was a liability. When we were hit hard by defense, the rack and pinion on which the pivot was driven was hit out of alignment and our shooter fell down, losing its angle and rendering us unable to shoot for the rest of the match. When we returned from competition, we spent a while thinking of ways to make our variable angle pivot more rigid and resistant to damage from defense, but with the limited time we had till our next competition, fixing the angle of the shooter and removing the variable angle pivot seemed to be the most realistic option.

Interesting facts:

The shooter subsystem has an automated feature that integrates a beam break sensor from the NMS!

Electrical:

CAD:



Drive Base Schematic: