復興實中機器人研究社
Taipei Fuhsing Private School Robotics Club

CRESCENDO
PRESENTED BY HAAS

TUMAZ

Taipei Fuhsing Private School Robotics Club

#6947

2024 Crescendo Season

Engineering Notebook

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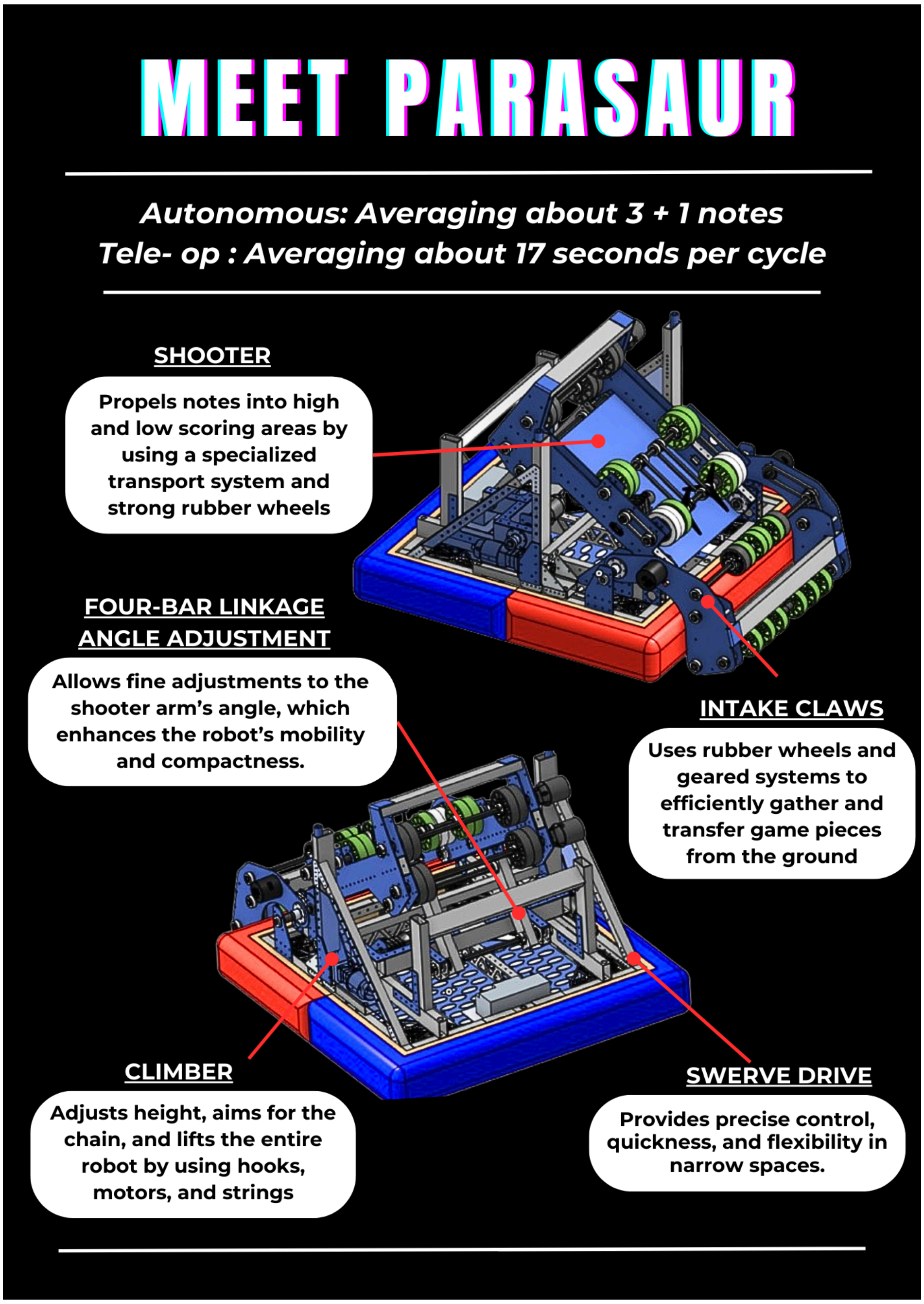
I. Overview

Introduction

Savage Tumaz #6947 proudly presents our 2024 Crescendo Season Robot: Parasaur. The robot got its name from the unique shape of the shooter, which imitates the Parasaurolophus's long, arching head crest. Furthermore, the deep rumbling sound of the shooter motors resembles the sound of a dinosaur growling. Within this engineering notebook lies a comprehensive breakdown of Parasaur's various subsystems and daily updates, showcasing the tireless dedication and collaborative effort of every Savage Tumaz team member throughout the five-weeks of build season.

Diagram



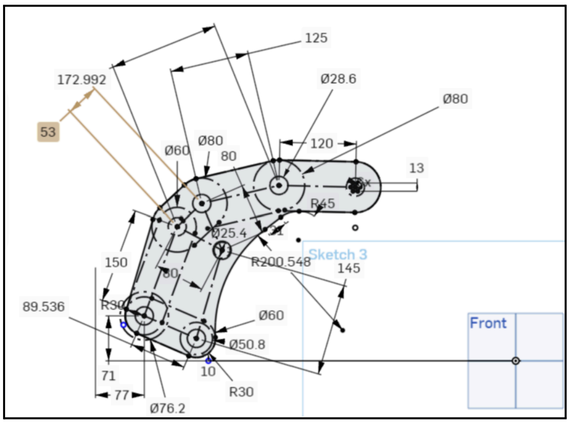
II. Structure Showcasing

Intake Claws “`BottomIntake`”

Foreword

The goal of this structure is to be able to pick up notes from the ground, as well as from the source where the human player drops notes. Ground pickup will still be a priority, as in the worst case, we would just have our robot pick up game pieces after the human player drops them on the ground. To ensure immediate intake upon impact with the game piece, rubber wheels will be needed along with a system of chained gears to roll notes up into the robot’s transfer system. These chained gears will link up to two motors spinning in opposite directions, each in charge of the movement of the top system of wheels and the bottom system of wheels respectively. Rubber wheels would also have to be spaced so that the note can curve along with the structure of the transfer system without being ejected mid-transfer.

Prototype I



Prototype I was made without accounting for our new bumper design, which had a larger radius compared to our original bumpers. Before the bumper redesign we had this year, we only had protection for our robot’s mainframe along one side and the four corners. Due to not knowing the updated dimensions of the new bumpers that we were going to make later on, we designed an intake system that worked with the old bumper system. This prototype checked all the boxes, being able to suck in-game pieces from the ground and deliver them successfully into the transfer system on the shooter's arm. One more inconvenience with this model was that it did not have a motor that controlled the entire arm’s raising and lowering. Due to the game’s restrictions on robot sizes, the entire arm must be within the perimeter of the robot’s bumpers at the beginning of the match. During the development of Prototype I of the intake arm, we did not plan on using a motor to control the movement of this claw because there wasn’t enough space to put another motor. Instead, we planned to use the shooter arm to push the intake claw down in front of the bumper at the beginning of each match and to never raise the claw after lowering it. This isn’t ideal, as this would increase the size of the robot, thus increasing the chances of it bumping into other teams and sustaining damage during matches. However, it was a workable intake arm for now.

Pros:

- Able to successfully take in notes from the ground with old bumper designs
- Able to transport note into shooting arm without being ejected
- Movement of the arm was possible despite the lack of a motor to control its raising and lowering

Cons:

- Not enough space to place a motor that controlled the movement of the arm
    - made the robot’s movement more limited
    - made the robot more vulnerable to damage
- Does not work with new bumpers

    - with the larger radius of the new bumpers, Prototype I could not touch the ground with the new bumpers incorporated

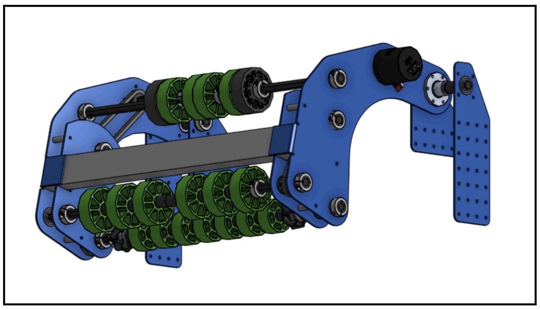
Prototype II

With the newly made and larger bumpers, we had to redesign the intake claws so that they could touch the ground and suck in notes on impact. Without moving the shooter's arm, we decided to increase the curve of the intake arm. However, with this change, we ran into some problems. One major problem was that the note could not be sucked into the intake arm as easily as it could before. Due to the increased angle that it had to the ground, the note would have to curve a lot more than it had to before during its initial contact with the intake arm. Another problem was that, even if the note could get into the intake arm, it would have to make another sharp turn to get onto the shooting arm, also due to the increased angle the intake arm now had. with the ground. To slightly alleviate this issue, we increased the height of the shooting arm by a little bit, but the note was still unable to move from the intake arm to the shooting arm without being ejected or stuck in between.

Pros:
- Able to touch the ground with the new bigger bumpers

Cons:
- Unable to perform steady intake of notes
    - Notes were either ejected from the transport system or got stuck in between
- Still did not have a motor dedicated to controlling the movement of the arm
    - The same minor issue as Prototype I: not a big issue, but still not ideal for our robot
- Could not handle notes from the ground as smoothly as Prototype I did
    - Because of the increased angle the arm now had with the ground, the note had to curve even more to get into the arm, making the intake arm less reliable and stable

Final Verison



To fix the problem of not being able to handle the game pieces without ejecting them as they are transported up into the shooter, we decided to add a bar in front to support the game piece as it is taken in. This has the same effect as the straps on top of the shooter's arm, preventing game pieces from leaving the robot. Adding this bar solved our problem of notes being ejected from the intake from the previous version. In the end, we also designed a motor that would gently put down the intake arm at the start, so that it wouldn’t be dropped too hard and break because of gravity. A camera was also added to the intake so that the driver station would have a better field of view from the robot’s perspective and would know when to start turning the intake wheels, also simplifying the process of aiming for notes to suck in.

Pros:

- Has a new motor dedicated to controlling the movement of the arm so that the intake arm doesn't get broken during its fall down to the ground
- Now able to take notes without ejecting them from the intake system
- Although the angle with the ground is increased, the bar and the wheels stabilize the game pieces so that it is still smooth during intake
- Installed a camera, allowing drivers to see notes from the robot's point of view

Cons:

- This design generated no new problems in our intake system

Transport System "`MidIntake`" and Shooting Structure "`Shooter`"

Foreword

The goal of this structure is to be able to shoot notes into both the high and low-scoring areas. Being able to score in the higher-scoring post is still the primary goal, as it provides more match points and possible ranking points. We decided that our strategy was to focus on being able to score points before improving our robot to be able to multiply our points during the match. The lower part of the shooting arm would be a transfer system for notes that enter from the intake system. using similar rubber materials as the intake system accompanied with a board on the opposite side, this transport system would be able to move the note to where it can then be shot upwards at an angle. The shooting would be done by four stronger rubber wheels, with two on each side perpendicular to the note, squeezing the note so that it can be "catapulted" towards the scoring post with its resilience.

Prototype I

With our first prototype, we were able to successfully create a shooting arm that could shoot the note a pretty far distance. With a 0.2-inch compression between the perpendicular rubber wheels on each side of the shooter's arm to squeeze the note, our shooter was able to shoot the note pretty far with this prototype. Since our shooting mechanism was pretty stable and our robot could shoot the note a considerable distance, we decided that we should lower the shooting arm to as small of an angle as possible, so that we would have the option of shooting notes from a further distance to save time. In hindsight, the 0.2-inch compression probably only worked because we had used medium-density fibreboards for quick prototyping, and they flex relatively easily under pressure.

Pros:

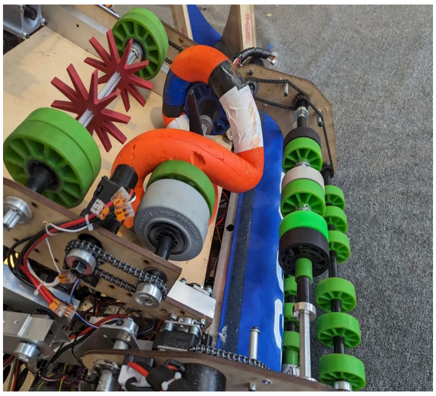
- Could shoot the note a very far distance
- Can adjust the note to be in the middle of the shooter if intake isn't as successful

Cons:

- Transport system
    - Fails to take notes from the intake arm without ejecting it
    - Sometimes fails to take the note from the intake arm

Prototype II

To fix the problem of not being able to transport notes from the intake arm successfully, we incorporated larger custom star-shaped pieces along with the original wheels on the transport. However, this generated a problem like the one shown in the picture below, that pieces would be rolled along the star because of its strong grip. Not only did this design eject a lot of notes that it took in and failed to shoot out, but this design accidentally made us break some of the game pieces we had for practice. An additional issue with Prototype II is that the color sensor installed at the side of the transport system did not detect the note in time, which caused the note to be stuck between main shooter wheels while intaking sometimes.



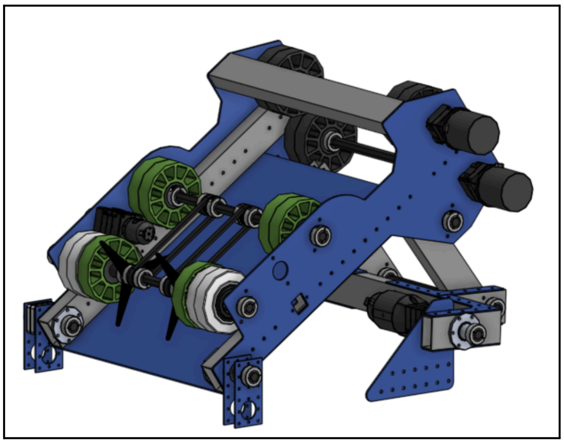
Pros:

- Fixed the problem of not being able to take in pieces from the intake arm
- Sometimes able to transport game pieces from the floor to the shooting area

Cons:

- Destructive to game pieces
    - The star-shaped pieces had too much of a grip on the notes
    - sometimes broke the notes when the wheels spun too quickly
- Could not detect the notes in time, causing notes to be stuck between shooter wheels while intaking sometimes

Final Version



After the failures of Prototype II, we decided to change out the star-shaped pieces for pieces with less "teeth", dubbed "ninja stars" by us because of their resemblance to ninja shurikens. By curving the teeth by a little bit and also reducing the amount of teeth on each piece of the rubber ninja stars, we were able to fix the problem of the original star-shaped pieces biting into game pieces and destroying them. As for the problem of notes being ejected in the middle of the transport system, a little blockading was done in between the ninja stars and the upper wheels of the transport system in order to keep notes inside their designated transport path, as shown in the CAD diagram above. To fix the problem of the color sensor not being able to detect the notes in time, we lowered the color threshold value in the code, making it easier for the sensor to detect notes despite their rapid traveling to the top of the transport system. By doing so, it wouldn't be stuck in between the shooting wheels and wouldn't interfere with the shooting process.

Pros:

- No longer ejected notes in the middle of the transport system
- A lot less destructive to notes during the process of transporting notes up the robot
- lowered color threshold value allowed robot to detect notes a lot more accurately, decreasing the probability of not detecting a note by a lot

Cons:

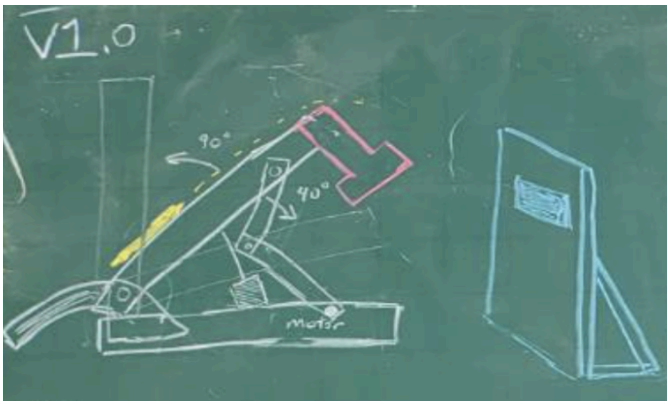
- This design generated no significant problems

Four-Bar Linkage Angle Adjustment “AngleSys”

Foreword

Because we had made a shooter with the ability to shoot notes a considerably far distance, we needed to be able to adjust the angle at which the shooter's arm was placed. To do this, we decided to make a small jointed arm placed under the shooter's arm in order to support its raising and lowering. We had several ideas from the start, but we started one by one with different prototypes.

Prototype I



This sketch on the blackboard was how we first envisioned we were going to make the arm move up and down. For the first design, we were inclined to use two smaller metal arms in between the shooter and the base of the robot. Using our design, with the bottom joint locked to the motor and the other two joints free for rotation, rotating the bottom metal arm would be able to cause the raising and lowering of the shooter's arm, as shown in the diagram below. The arm would have to be able to rotate from as low of an angle as possible up to nearly 90 degrees so that it would be able to have an optimized range of motion for shooting and aiming. Another requirement that we wished our robot could meet was for it to be under 66 centimeters tall so that it would be able to have more mobility under the stage during the teleoperated period. To calculate how long each arm needed to be, we used the law of cosine to find a possible combination of the two arms, and we got the result that two 25-centimeter long arms would be able to move freely from around 28° up to around 80°. This prototype worked kind of well, but the placement of the motors was interfering with other parts of the robot, and the rods supporting the arms also started to bend when we tried to lift the arm, which is why we ultimately tried our second idea.

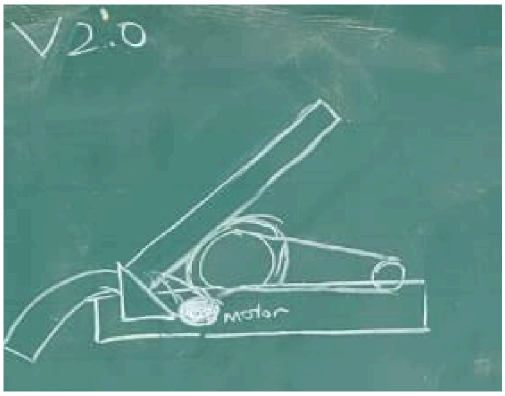
Pros:

- Able to move a large range of angles up and down to score from different distances
- was good to lift the arm up until the shooter arm became too heavy and started bending the rods
- low enough to pass through the stage in the middle

Cons:

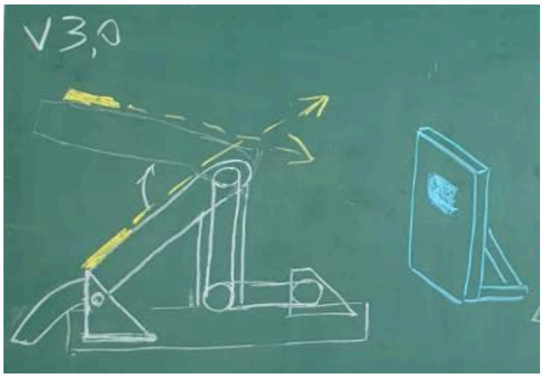
- Won’t be able to reach the amp and drop the game piece steadily, like some other designs are theoretically able to do
- Motors at awkward places

Prototype II



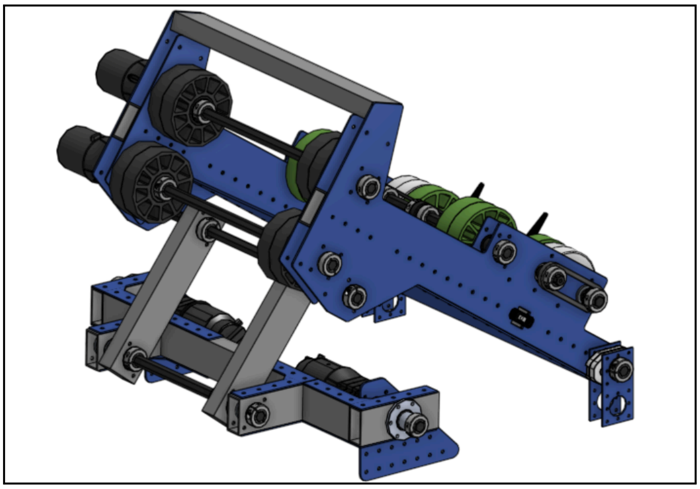
For Prototype II, instead of using a double jointed arm to control the angular movement of the shooter arm, we decided to use a motor around a small motor to help turn a larger motor, hoping that it would be able to help move the angle of the shooter arm directly up and down, instead of using a jointed arm in the middle to do so. This solution seemed like the easy go-to one after our first one didn't succeed. This design didn't have such a complex structure and didn't require much advanced math to calculate the lengths of arms, but the main problem we encountered while making this structure was that the motor wasn't strong enough to lift the entire arm all by itself, despite the power being transferred from a small gear to a large gear. This design also sometimes encountered problems like gear skipping, which is why we ultimately ended the making of this design without finishing it.

Prototype III



For Prototype III, we decided to use another design that we had in mind, which was mainly developed due to us wanting to drop the notes into the amplifier directly. This design involved a taller metal beam in the middle and a chain system that would link all the way from the bottom to the top in order to move the shooter arm by its upper end. However, after some testing was done with the testing of this design, it was proven impractical, as the drop would be extremely inaccurate due to the metal beam being too far from the target even when the robot was directly beside the amp. The movement of the shooting arm by a single hand also still proved to be a challenge even with more gear changes to minimize the torque needed to move the shooter arm. Those are the reasons why we ended up not using our third prototype either.

Final Version



Our final solution to raising and lowering the shooting arm to accommodate different situations during the games was closer to the design of Prototype I. however, in this final design, instead of just using two arms, one upper arm and one lower arm, we decided to use a much wider design. This ensured for a much more stable raising and lowering system for the shooter arm, and the rods that supported the movement were no longer bending out of shape. From the original 25 cm upper arm and 25 cm lower arm, the design was shrunk down to 20 cm upper arm and 15 cm lower arm. This had negative effects on the shooter arm's range of angular motion, as it could not only move from 28° to a little over 60°. This meant that our robot was still able to go under the stage in the middle , but would have a lower chance of getting the notes in if we were to shoot from a really close range where an incline angle of larger than 60° would be necessary. Apart from the dimensions, the base was also changed to be much larger and covering the entire horizontal of the apparatus. Motors were also moved inside because of the awkward placement of motors in the first prototype. This made the arm easier to fix after future collisions or "injuries". Our final design, however, was still not able to make our robot score into the amplifier accurately, so we would have to rely on our teammates for that aspect of the game.

Pros:

- System became much more stable with the widening of the base and the inclusion of two upper arms so far apart, as well as a horizontally long base
- Able to pass under the stages in the middle

Cons:

- Range of angular motion decreased due to the smaller dimensions of the new arms
- Still unable to reach the amplifier and shoot it consistently by dropping notes into the hole

Climber

Foreword
We made a climber for the usage of climbing up the chain in the middle of the contest arena, and how we want it to work is that it can change the height of the climber, aim for the chain, and bring up the whole robot with two climbers. In order to make our climbers have good usage of bringing up the whole robot, we planned to use hooks, motors, and also strings in our design.

Prototype I
For Prototype I, we decided to put a motor on the base, then tie a string on the the motor with a pole extended out so that the usage of the string is to pull down the hook, so that we can use the force to bring our robot up. However we couldn't get the hook to the previous position, so in order to solve this problem, we decided to use a spring to let the hook reposition itself. Next, we decide to stick the hook on a circle pipe which connects a string on it to let the motor pull it down. Then, we put the circle pipe into a rectangle aluminum square tube. Because we needed to prevent friction between the pipe and the tube, we left some space in between.. Afterwards, we connected all the things together and then screwed it onto the robot. The results we got from our tests were pretty successful, so we decided to use the prototype 1 without changing it.

Pros:
- Doesn't need much material to build; relatively easy design
- The motor and string can supply big amounts of energy to pull up our robot

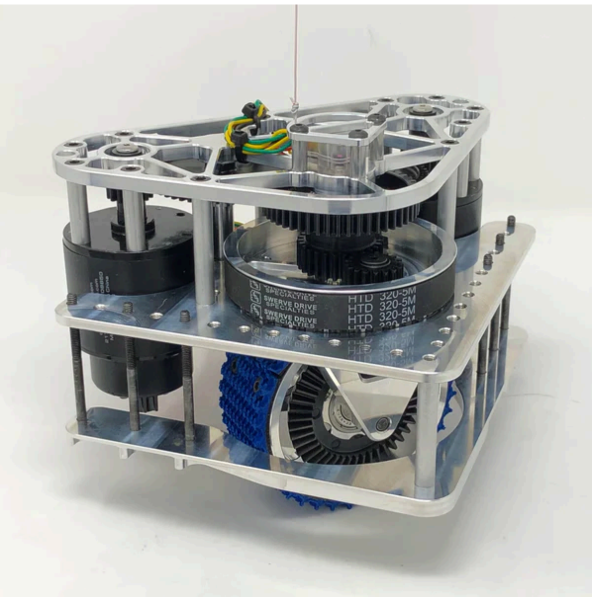
Cons:
- String length on both sides of the climbers need to be set to the same length and thickness, or else it would be hard to let the hooks rise and lower at the same time
- the string on the motor need to be tied at the same thickness or else the string might miss the track and stop the hook from going up

Final Version
The prototype 1 had some cons, but most of these were just inconveniences and didn't really affect our robot's performance during the match. Therefore, we decided to use the prototype 1 as the final version of our climber, saving a lot of time and money, while also avoiding additional weight that the robot would have to pull up.

Swerve Drive

Foreword
The Swerve Drive, also known as the "swerve and steer" or "holonomic" drive, revolutionizes robot mobility. Unlike traditional tank drives or Mecanum wheels, Swerve Drive allows for independent wheel movement in both translation and rotation. Each wheel can pivot freely, enabling precise control and unmatched agility.

Structure of Swerve Drive
Swerve Drive consists of individual swerve modules—each comprising a wheel, motor, and steering mechanism. These modules can rotate independently, allowing the robot to move in any direction without turning the entire chassis. Each wheel is powered by a motor (often a brushless or brushed DC motor). The motor drives the wheel's rotation for both translation and rotation. Swerve modules incorporate a steering motor (usually a servo or a small motor). The steering motor adjusts the wheel's orientation, allowing it to point in any direction. Swerve drive kinematics use a common coordinate system. Positive x values move toward the front of the robot, and positive y values move toward the left.



Pros:
- Allows robots to navigate tight spaces, execute intricate movements, and avoid obstacles effortlessly
- Excels in tasks like collecting game pieces, climbing, and positioning accurately
- Simplifies driver control by allowing field-centric movement (where the robot moves relative to the field, not its initial orientation)
- Can be adapted to various robot sizes and game challenges.
- Versatile for both offensive and defensive strategies.

Cons:
- Code for the swerve drive is substantially harder to write than the Mecanum drive
- Need more motors (8 instead of 4), hence it being a lot financially taxing
- Heavier than other kinds of drivetrains due to more complex structures
- Harder to repair compared to other drives
- Uses more power due to having 2 motors on each edge

III. Programming

Codebase

Foreword

We have traditionally been a LabVIEW team, mainly due to our mentor's proficiency with the language. However, our team captain this year discovered the limitations of LabVIEW when comparing our previous years' robot with teams with other codebases. We came to the conclusion that LabVIEW was quickly becoming a burden to us, despite its initial appeal as a graphical programming language. (also it is a pain to sort out all those lines) This year, we pivoted our programming team, for the first time, to Java, for its wide community support and since it was already taught in our school's AP CSA course.

Drivetrain

Prior to Build Season, we have already purchased and designed a chassis for MK4i's as our drivetrain this year. As a result, we bought ourselves some time to program the drivetrain in advance. As we noticed from following the FIRST community on Discord, Reddit, and Chief Delphi, multiple teams have already completed a swerve code with robust features readily available on GitHub. As a result, we decided along the mentality of "if it ain't broke; don't fix it" and chose a relatively bare-bones Command-Based Swerve code from team 364 and used it as our basic codebase. From then, we tested the encoder values in addition to feedforward values to tune the codebase to our robot, with little issue. Since we successfully tuned the encoder values, we decided to integrate more features that we thought would benefit the robot in general, no matter the released game – specifically PhotonVision, AdvantageScope, and PathPlanner.

PhotonVision

Our team has used a Limelight for vision processing since the 2022 Rapid React game. Like other teams, we were leveraging the reflective tapes as vision targets in order for our robot to aim. However, this method has never really worked, partly because of the aforementioned issues with LabVIEW programming, but mostly because of our programmer's proficiency in dealing with vision targets. This year, we switched to PhotonVision on an OrangePi 5 after seeing its promising results on its community Github page. We attached two cameras to our robot this year, one at the back for AprilTag processing and robot localization, and the other for centering the intake with the note. The first mechanism was fairly easy to implement before build season, where we wrote a separate Vision subsystem in order to supply the pose calculated on the coprocessor into a SwervePoseEstimator. For centering the intake, we get the value of the best target supplied by PhotonVision's object detection, then translate via PID control to center the note, then pick up the note autonomously.

AdvantageScope

Additionally, we felt the need to visualize data collected on our robot with a simple interface. AdvantageScope proved to be the most versatile in that regard, even allowing us to instantly replay matches to review bugs and train drivers. We are currently using AdvantageKit to log all matches onto a USB.

PathPlanner

The final piece of the FRC autonomous puzzle is PathPlanner. This caused the most issues out of all the modules, as we were having trouble with PID tuning and publishing Autonomous routines. As of now, we are still tuning the right PID values to minimize errors for our autonomous routines.

Autonomous with PathPlanner

Foreword

We currently have designed three sets of autonomous routines, with great adaptability to generate autos on the fly with PathPlanner.

1. AmpPosAuto, where we shoot one pre-loaded note into the speaker, get the note right in front and get the first two notes from the Amp in the center.
2. AmpPosAuto, where we shoot one pre-loaded note into the speaker, get the note right in front and get the third and fourth notes from the Amp in the center.
3. StagePosAuto, where we shoot one pre-loaded note into the speaker, get the note right in front and get the sixth, and then fifth notes from the Amp in the center.

As of now, we are currently debugging and redesigning the paths to make sure that our robot lands in the correct places every time and doesn't veer off its designated path because of failed PID tuning.

Semi-Autonomous Commands in Teleop

Active Commands

```
autoPickupButton.onTrue(autoGrabNoteCommand);
/* Starts rotation of BottomIntake and MidIntake motors, aim the
note using the Intake Camera, then move forward to grab note in
front of robot */
```

```
autoShootButton.onTrue(autoShootCommand);
/* Charges up the shooter wheels, make sure the angle is at
setpoint, rotate the chassis, then start MidIntake motors to pass
note into the shooter once the wheels reach full speed */
```

```
autoToSourceButton.onTrue(autoToSourceCommand);
/* Uses PathPlanner to drive robot to the source area */
```

```
autoToAmpsideButton.onTrue(autoToAmpsideCommand);
/* Uses PathPlanner to drive robot to the area between the amp and
the speaker to prepare to shoot note */
```

```
autoToMiddleButton.onTrue(autoToMiddleCommand);
```

```
/* Uses PathPlanner to drive robot to right in front of the
speaker to prepare to shoot note */
```

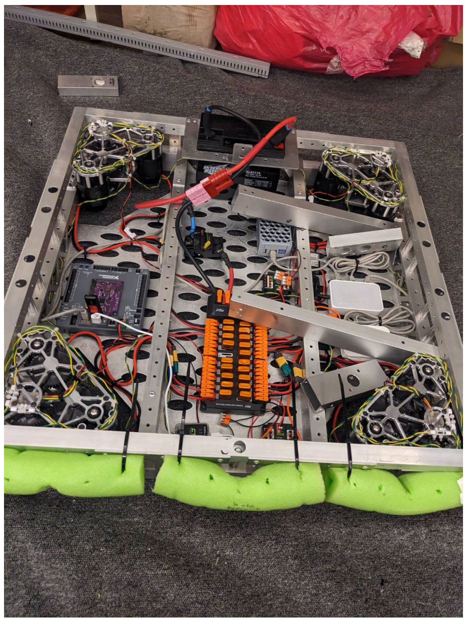
```
autoToStageButton.onTrue(autoToStageCommand);
/* Uses PathPlanner to drive robot to stage area and prepare to
shoot note */
```

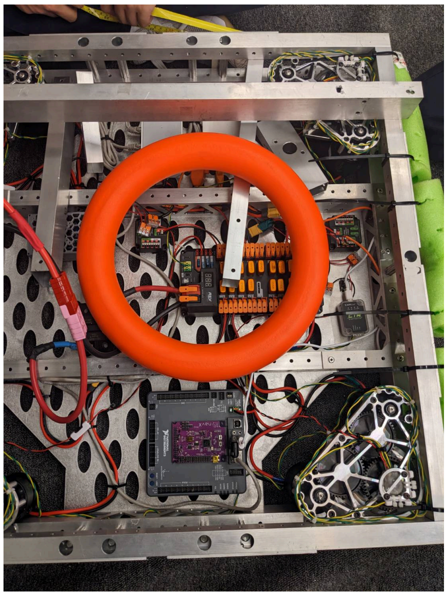
Passive Commands

```
AutoSpeakerAngleCommand → default command
/* Passively raises angle of shooting arm to designated angle for
scoring in the speaker */
```

```
AutoTrapAngleCommand → default command
/* Passively raises angle of shooting arm to designated angle for
scoring in the trap */
```

IV. Daily Updates

1/ 16 (Day 1)	
Mechanical Team	
Progress	The mechanical team worked on measurement problems with some frameworks, as certain aluminum rectangle tubes did not fit into the structure. Additionally, we addressed issues with our intake system by enhancing friction, achieved by adding spikes to our original rubber wheels. We also worked on the prototype of the elevator.
Problems	Installing the intake structure requires careful planning to ensure proper integration with the existing system. Increasing friction can enhance efficiency and prevent clogging, but measurement problems may arise during installation. These challenges must be addressed through analysis and adjustments for a successful outcome.
Solutions & Future Plans	We replaced assembly components that were not the right size to achieve a more compact yet sturdy structure. The notes were too large to fit our planned structure. To solve this problem, we elevated our system to create more space to work with. Additionally, we explored alternative methods for the intake system, placing particular emphasis on adding spikes and additional rubber wheels. We experimented with adding spikes to the original intake system, which relied on using rubber wheels to create friction with the object.
Pictures	 

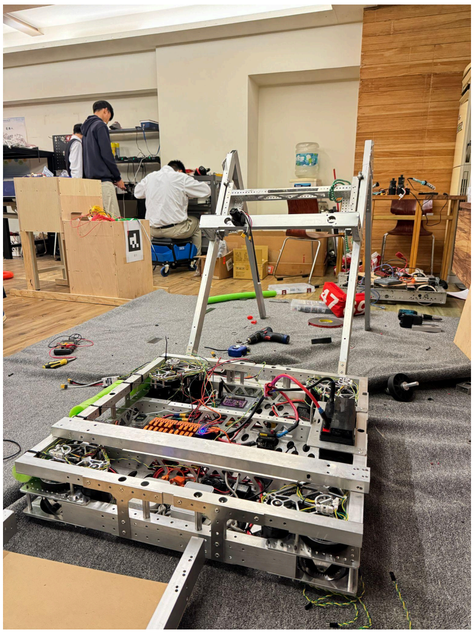
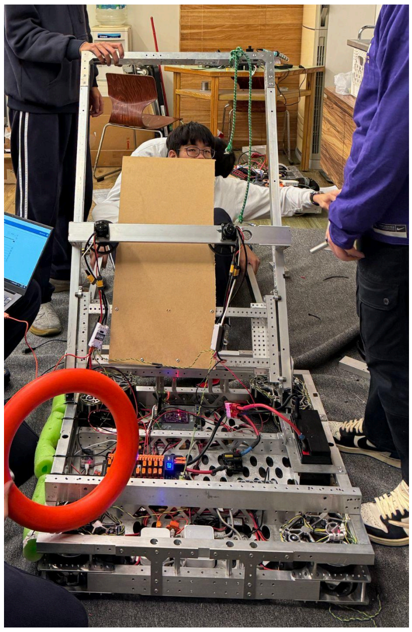
Design Team	
Progress	The design team dedicated extensive efforts to refining the wooden boards for both the intake and shooter components, meticulously crafting and optimizing their structures to ensure durability and functionality. In addition to this crucial task, the team also embarked on mapping out the broader direction for our robot's overall design, envisioning its form and function, and laying the groundwork with preliminary measurements.
Problems	Issues such as inconsistent alignment of the wooden boards and discrepancies in the initial measurements have posed obstacles to the seamless integration of components, requiring careful troubleshooting and adjustments to ensure optimal performance.
Solutions & Future Plans	Since we aren't sure how the results will turn out, we will focus on making further progress on the actual product so we have a better grasp on what we need more space on.
Pictures	 

1/ 17 (Day 2)

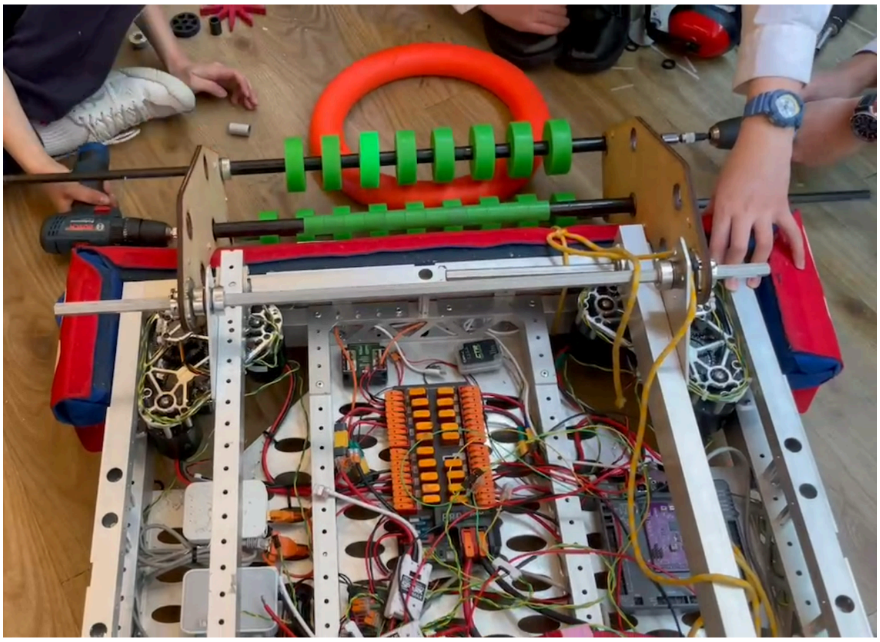
Mechanical team	
Progress	We finished the prototype. However, the mechanical team is trying to improve our intake system since we found some issues with the old one. We also spot some bugs in our codes, and we are trying to get rid of it as soon as possible. We improve the shooting system and to enhance stability, which we add parts to fix the things that we used on the robots.
Problems	We are currently debugging code to fix identified bugs while also working on improving our intake system. One challenge we're facing is ensuring that the new parts we're adding are properly scaled to fit onto the robots more effectively. Additionally, we are in the process of building new structures to enhance the functionality of our intake system. As part of this process, we need to relocate and adjust the size of screw holes to accommodate the changes. It's important to address these issues systematically to ensure the successful integration of the new structures and improve the overall performance of our system.
Solutions & Future Plans	We are trying to make a more stable shooter since we found out that the original one is just a prototype yet, and there are still a lot of places we can improve. We change the scale and add things that were 3D printed onto the motor which might probably make it more stable. Moreover, we fine-tune the location and sizes of screw holes which we are trying to stabilize the motor, so the direction it is shooting, and the area it touches the plates are the same.
Pictures	

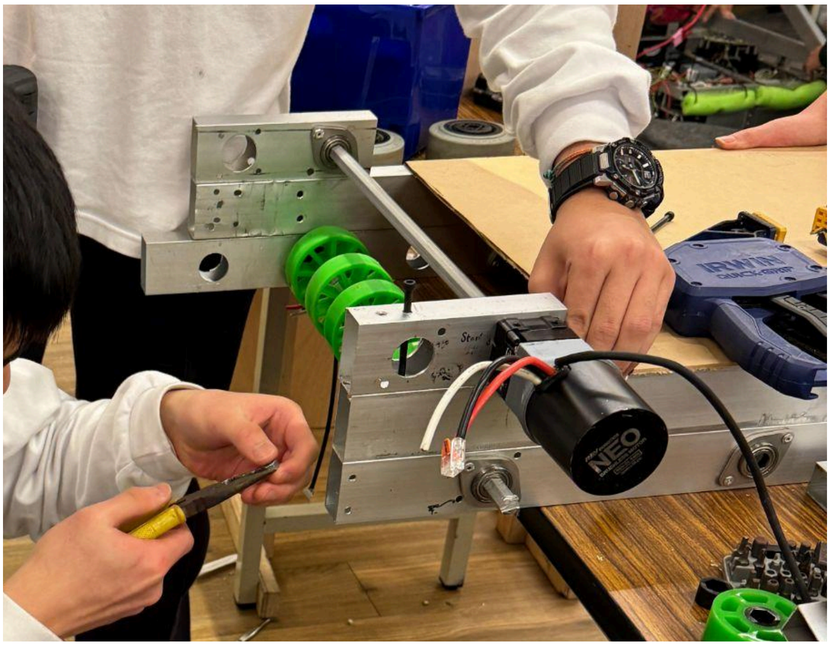
	  

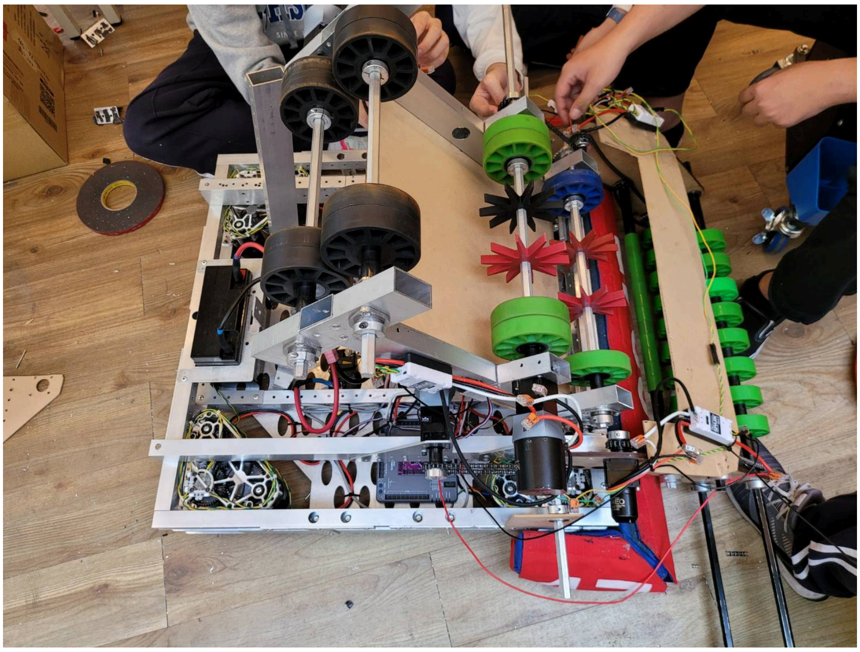
1/ 18 (Day 3)

Mechanical Team	
Progress	The mechanical team worked on a prototype shooter and calculated the elevation angle for the shooter. We used some parts from our design from last season. We placed the motors in front of the shooting system and placed wheels horizontally by the two sides.
Problems	Further analysis revealed that the horizontal placement led to a dispersion of energy, reducing the effectiveness of the shooter's propulsion. Conversely, the vertical orientation concentrated the force, resulting in a more powerful and focused trajectory.
Solutions & Future Plans	We will change it into a vertical shooter to increase its power (the wheel that pushes the note out will be placed on the top and the bottom of the shooting track's exit). The motors will also be placed by the side of the structure and an axis of wheels will be added in front of the structure instead of being placed by the sides.
Pictures	 

1/ 19 (Day 4)

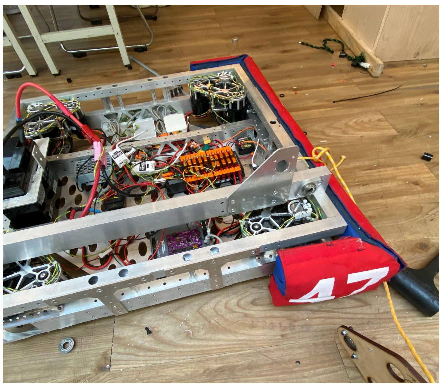
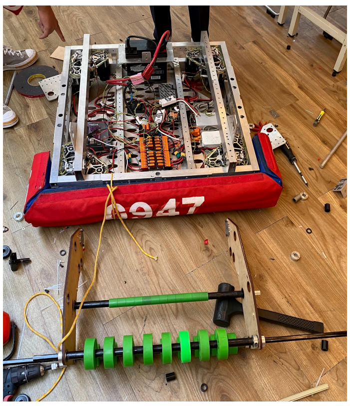
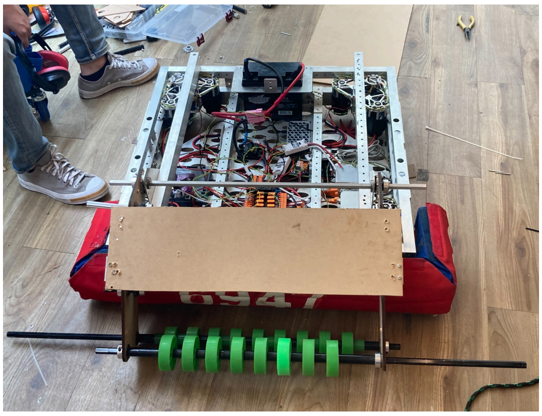
Mechanical Team	
Progress	Following the identification of previous issues, our team diligently tackled the challenges by developing a new prototype for the shooter and refining the intake mechanism. In our efforts to enhance functionality, we incorporated additional rows of rubber wheels into the intake system, aimed at optimizing the efficiency of note intake and elevating their performance within the system.
Problems	The row of wheels on the lower end was too big and couldn’t take in the notes consistently. As a result, the instrument's performance suffered, causing disruptions in the music flow during live performances.
Solutions & Future Plans	We changed the size of the lower row of wheels from three to two, which can make the distance of the wheels to the ground smaller, and can decrease the percentage error of gaining notes.
Pictures	

	
Design Team	
Progress	In response to testing results indicating weaker power with a horizontal shooter, the design team devised a new prototype featuring a vertical shooter configuration. By positioning the note-pushing wheels at the top and bottom of the shooting track's exit, along with relocating the motors to the side of the structure and adding an axis of wheels in front, the team aimed to significantly increase the shooter's power and efficiency.
Problems	The vertical shooter prototype poses a challenge due to potential alignment issues with the bumper. The bumper will limit the angle that the shooter can turn.
Solutions & Future Plans	To mitigate alignment issues with the bumper in the vertical shooter prototype, the design team plans to conduct thorough testing and adjustments to ensure proper alignment and clearance. Additionally, the team will explore potential modifications to the bumper design to allow for greater freedom of movement and adjustability in the shooter's angle.

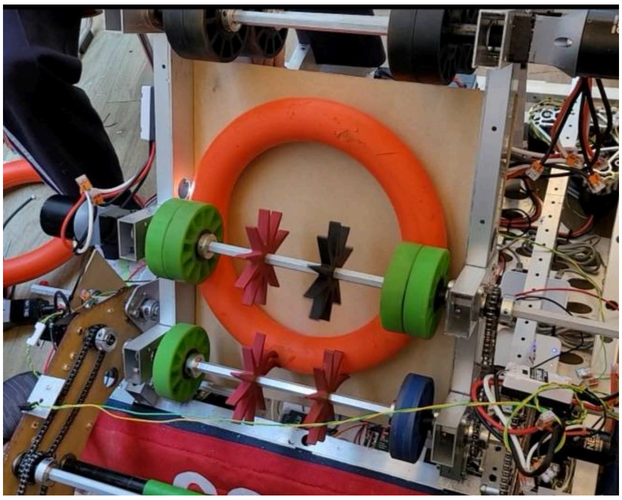
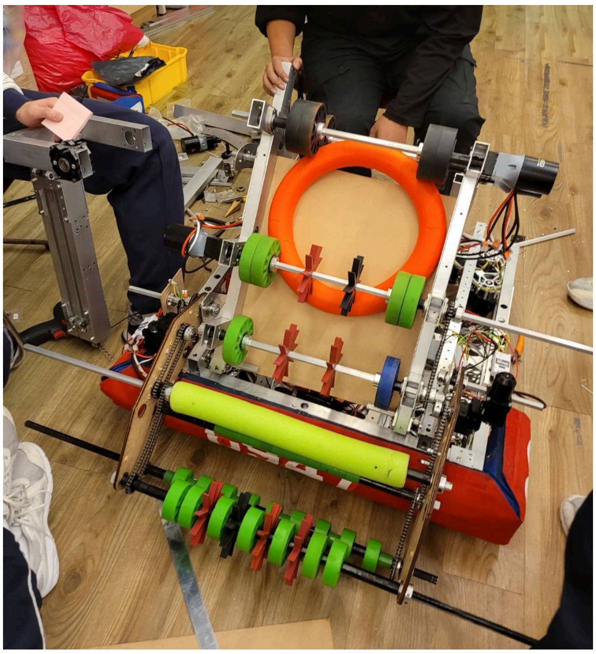
Pictures	

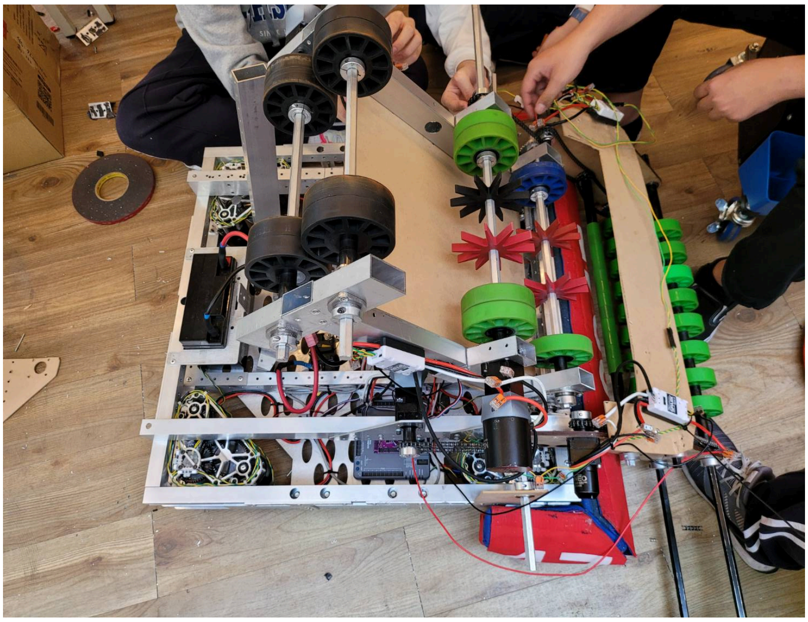
1/ 20 (Day 5)

Mechanical Team

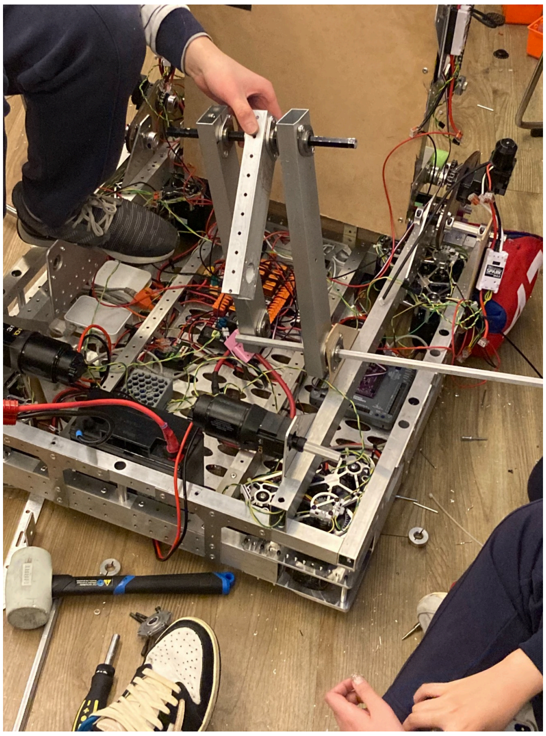
Progress	The mechanical team, after successful integration of the intake prototype with the robot used during testing, dedicated efforts towards enhancing the efficiency of the shooter mechanism. This involved a comprehensive approach, which included the installation of supplementary motors and reinforcing the structural integrity of the shooter assembly to ensure optimal performance under varying conditions.
Problems	Notes retrieved by the intake mechanism often failed to transition smoothly onto the designated shooting track, impeding the fluidity of the process. This setback was primarily attributed to insufficient power exerted by the system at the point of transition, resulting in frequent blockages and disruptions in the note's trajectory.
Solutions & Future Plans	We will add wheels at the junction of the intake and the track so the wheels can push the notes onto the track.
Pictures	   

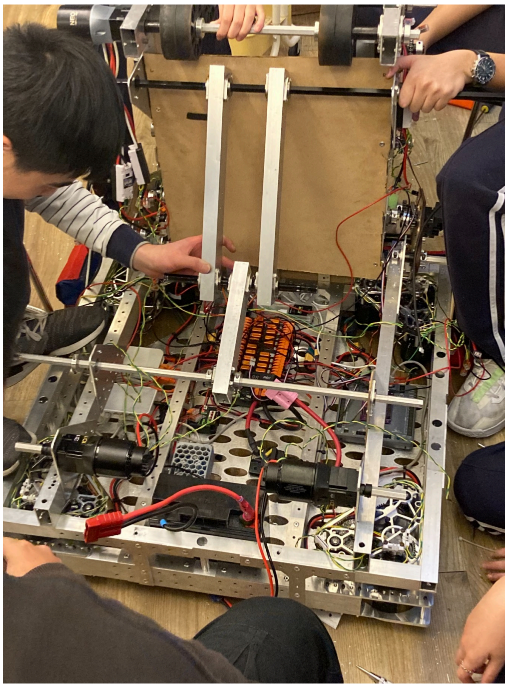
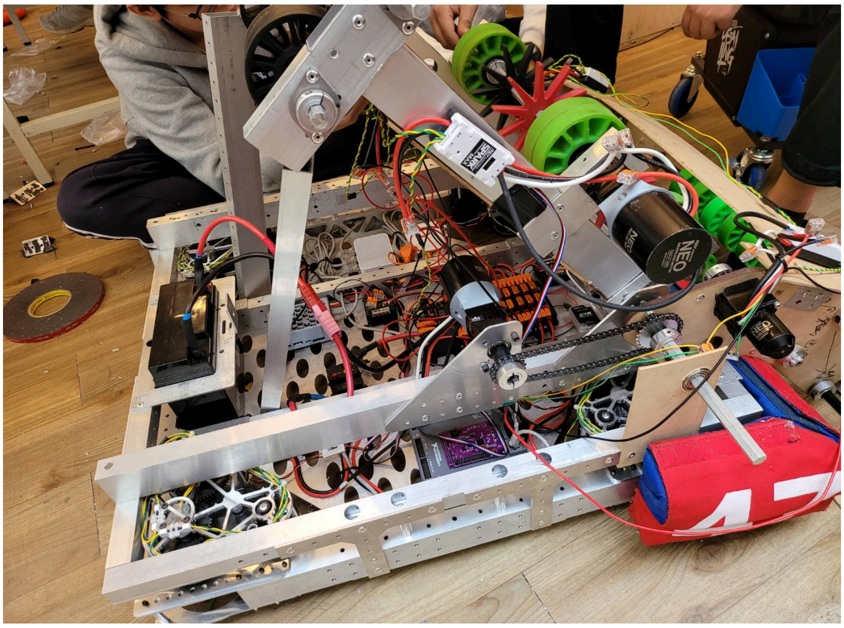
1/ 21 (Day 6)

Mechanical Team	
Progress	We adjusted the width of the intake to make obtaining notes from the ground more fluent. We also adjusted the elevation angle and worked on the hanging system. After these, we can complete our robot prototype. We connected our intake and shooter prototypes to the main structure for testing.
Problems	We're facing multiple problems: our motors are overpowering the intake, notes are flying too high and disconnecting from the shooter, and there's no clear plan for the rest of the structure to score points. We need solutions fast to improve our performance.
Pictures	 

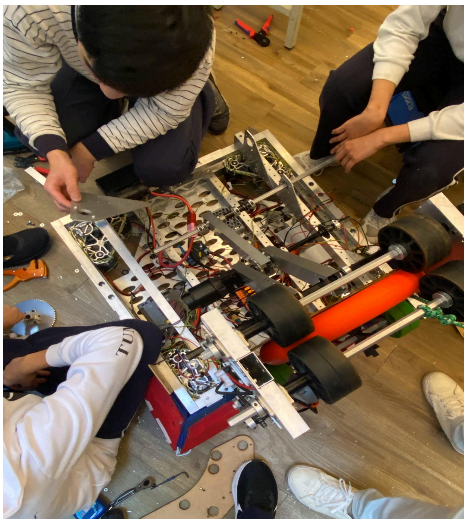
Design Team	
Problems	We're facing multiple problems: our motors are overpowering the intake, notes are flying too high and disconnecting from the shooter, and there's no clear plan for the rest of the structure to score points. We need solutions fast to improve our performance.
Solutions & Future Plans	In response to the challenges we're facing, we're considering several actions. Firstly, we're planning to relocate the motors inward to better align with the intake system, which should help mitigate the overpowering issue. Additionally, we've implemented a strategy to elevate an axis to intercept and block the notes from flying too high, thus maintaining a smoother workflow with the shooter. However, it's evident that further testing and meticulous planning of the elevator system are necessary to optimize its functionality and ensure seamless integration into our overall mechanism. As an alternative approach, we're open to discussing potential adjustments to our strategy to better adapt to the current circumstances and enhance our overall performance.
Pictures	

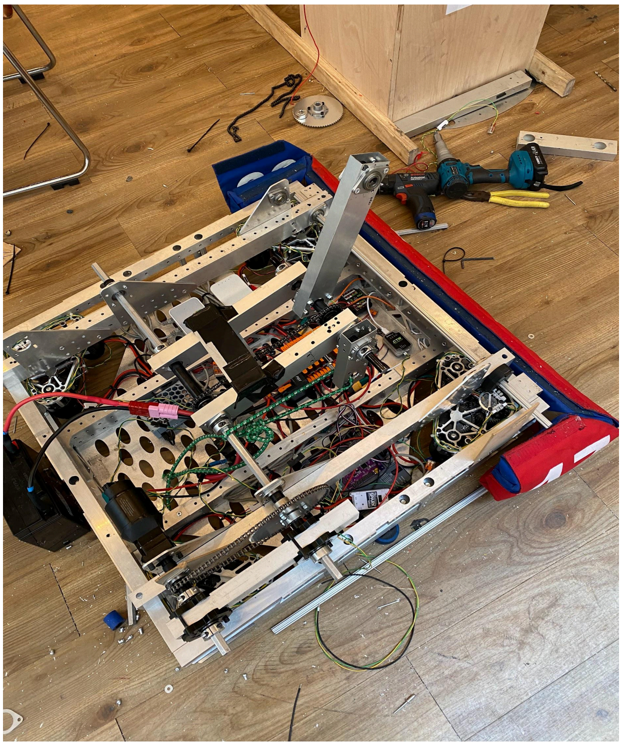
1/ 22 (Day 7)

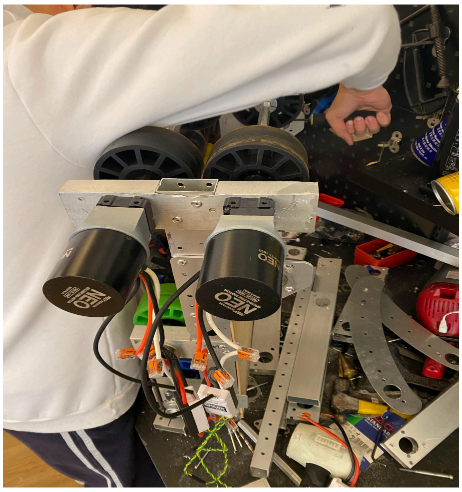
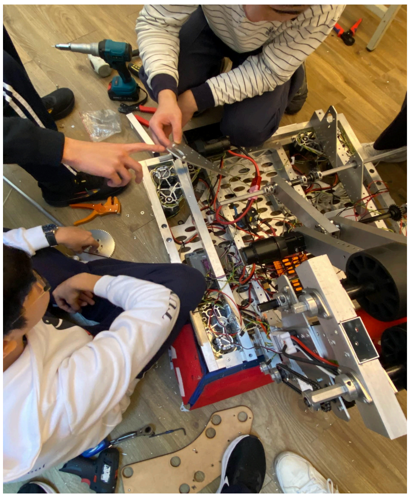
Mechanical Team	
Progress	To optimize the amplification structure, the mechanical team implemented enhancements by incorporating aluminum rectangle tubes into its design. This strategic addition not only reinforces the structural integrity but also contributes to the overall stability and performance.
Problems	Miscalculations in measurements for the amplification structure caused issues, particularly with the axis connecting aluminum rectangle tubes. Additionally, the supporting structure's angle led to component clashes. We must revise measurements, recalibrate calculations, and adjust the design to resolve these issues promptly.
Solutions & Future Plans	We moved some attachments and redid the measurements. We will have to change our planned structure so that aluminum tubes will collapse into one another. We will make further changes to our plan so that it can fit our new measurements. We will change some lengths of the aluminum tubes and the space that the supporting structure uses to increase the angle our shooter can turn.
Pictures	
Design Team	
Progress	The design team has been diligently working on conceptualizing and prototyping the next iteration of the robot. Building upon the mechanical team's advancements with the amplification structure using aluminum

	rectangle tubes, we've been focusing on incorporating these elements into the overall design framework.
Problems	Miscalculations in measurements for the amplification structure caused issues, particularly with the axis connecting aluminum rectangle tubes.
Solutions & Future Plans	We will adjust the design to accommodate the collapsible nature of the aluminum tubes, allowing for more flexibility and efficiency in the overall structure. Additionally, we will explore opportunities to optimize the robot's maneuverability by adjusting the lengths of the aluminum tubes and optimizing the space allocation for the supporting structure.
Pictures	 

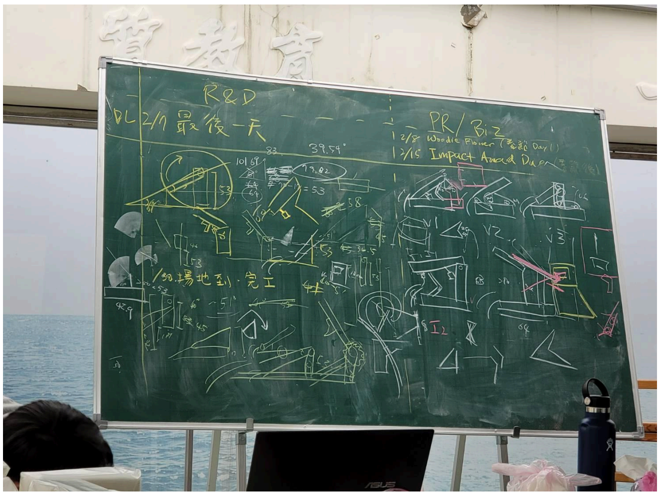
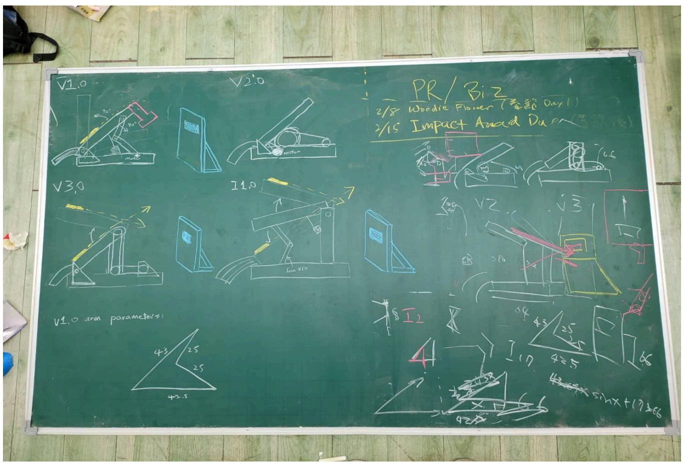
1/ 23 (Day 8)

Mechanical Team	
Progress	We separated the intake system and rebuilt it. We also built and made improvements to the system that manipulate the angle the shooter is facing.
Problems	The original prototype's wood piece caused measurement issues for the intake system. Inconsistencies in the distance between intake wheels are leading to chain problems. Moreover, the shooter's excessive weight is rendering its backbone ineffective, compromising consistency and efficiency due to an inability to support the necessary angle. These issues demand urgent attention to ensure the system operates smoothly and efficiently.
Solutions & Future Plans	We took down the intake system and the shooter to make further improvements so that it not only works separately but it also can work when paired with other components
Pictures	 
Design Team	
Progress	We've designed and constructed enhancements to the system responsible for adjusting the shooter's angle, further refining its performance.
Problems	The shooter's excessive weight is rendering its backbone ineffective, compromising consistency and efficiency due to an inability to support the necessary angel.
Solutions & Future Plans	In response to the issues encountered with the excessive weight compromising the shooter's backbone and its ability to maintain the necessary angle, a potential future planning idea involves integrating a hydraulic lever system. This hydraulic system could provide the

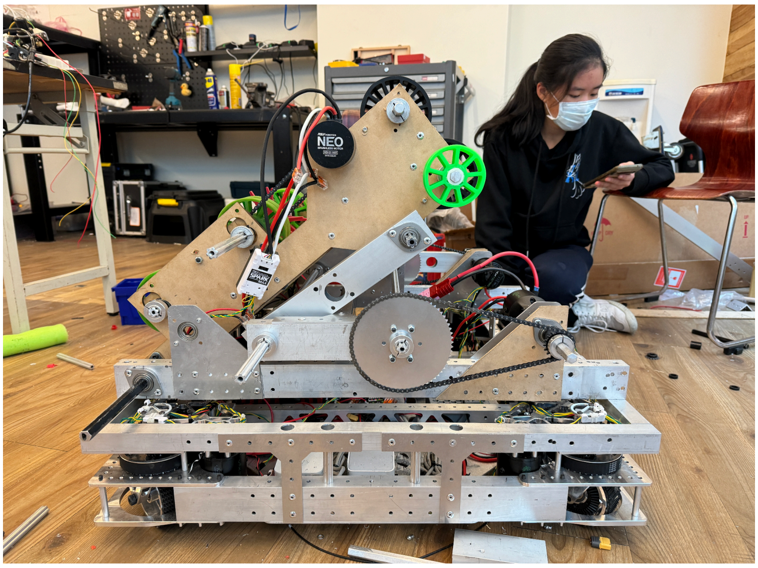
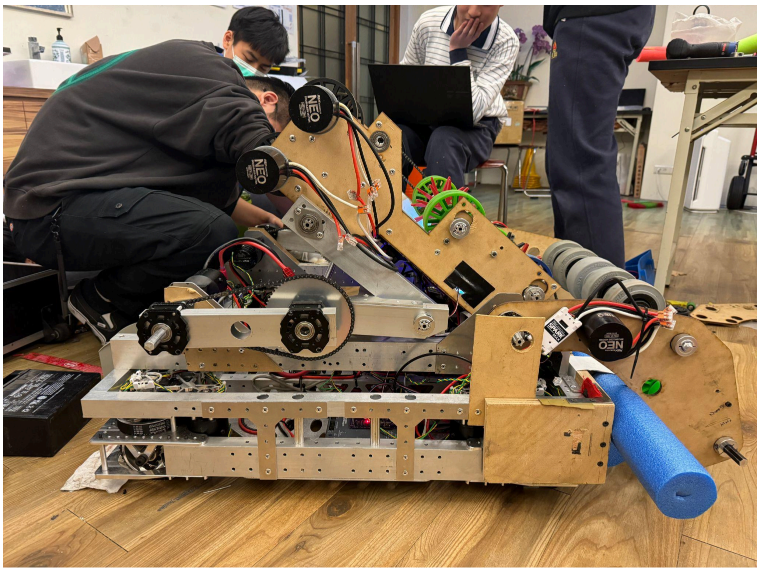
	necessary support to stabilize the shooter while also offering precise control over its angle adjustments.
Pictures	

1/ 24 (Day 9)	
Mechanical Team + Design Team	
Progress	We began the design process of a series of mechanical structures called "shooters." In our most recent design session, we carefully sketched and conceptualized two different types, now designated Version 1 and Version 2. Our focus is on exploring different architectural configurations with an emphasis on optimizing performance and functionality. As the iteration phase progresses, our goal is to achieve a harmonious balance between form and function, ensuring the practical suitability of these "shooters" in a variety of situations.
Problems	There are some problem on both version 1 and both version 2 Version 1: The damping is too small and the overall shooter is unstable. Version 2: It is a structure in which a small gear is connected to a large gear and then a small gear is connected. This causes the small gear at the tail end to have insufficient torque and the motor to have insufficient power to drive the shaft.
Solutions & Future Plans	To solve this problem, we intend to design other structures. Therefore, we designed two other types and named them version 3 and idea 1.
Pictures	 

1/ 25 (Day 10)

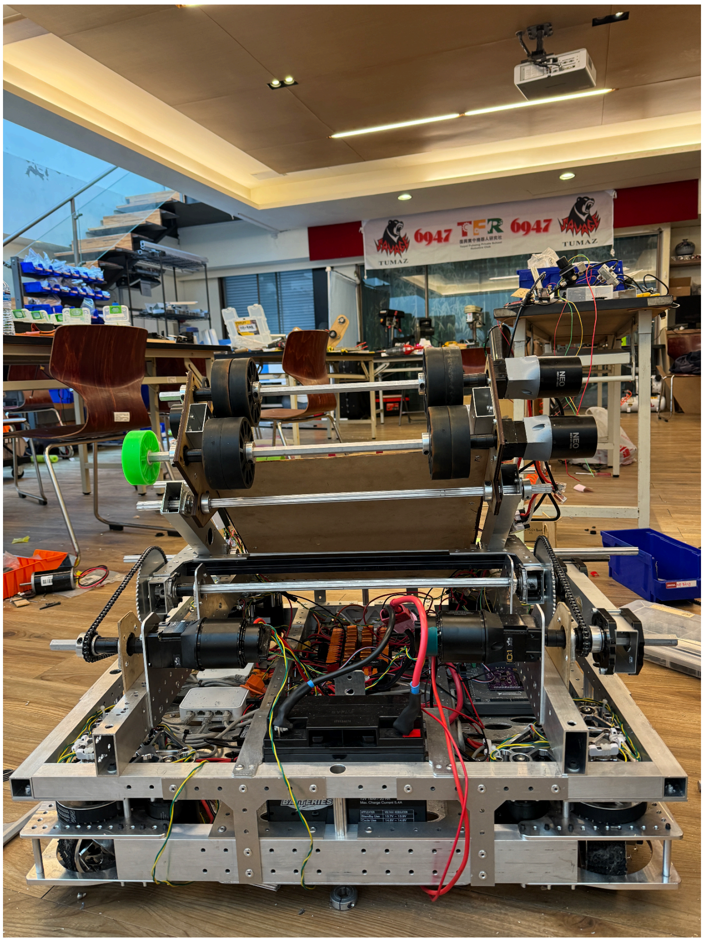
Mechanical Team+ Design Team	
Progress	We addressed our problem from version 2 of our prototype and tried a new design(version 3) that connects the gears and axis directly. Due to the problems from version 3 mentioned below, we formed a new idea of connecting motors from the base to rectangular
Problems	From tests we did on version 3, we found out that the power from the motors exceeded the expected. This caused the gears to jump chain and the axis to bend.
Solutions & Future Plans	In response to the challenges encountered with our current prototype, we've devised plans to develop various iterations aimed at resolving these issues. Idea 1 requires further testing to refine its functionality. Additionally, we intend to rebuild Version 1 and incorporate a hydraulic lever to enhance stability and address any structural concerns. These steps represent our proactive approach to iteratively improving our design and achieving optimal performance.
Pictures	 

1/ 26 (Day 11)

Mechanical Team	
Progress	The mechanical team explored various combinations of gears to optimize performance. Through testing and analysis, we sought to identify the most efficient configuration that would minimize energy loss and enhance overall stability. We wanted to find the combination and placement that would give us best efficiency and control over the shooter.
Problems	Gear to gear connection will lead to lost energy when transferring throughout the system to the shooter.
Solutions & Future Plans	We will try a new method for the supporting system using aluminum square tubes to better connect the structure.
Pictures	 

Design Team	
Progress	We worked on the new bumper which we can change the color by flipping. By integrating an additional piece of cloth that can be easily flipped up or down, we've devised a system that allows for seamless color transition without the need for multiple sets of bumpers.We will not need to make two sets of bumpers for two different alliances.
Problems	The sewing machine could not sew through the hook and loop fastener.
Solutions & Future Plans	We can use the stapler or do the sewing process by hand. If these do not work, we will check the sewing machine to see if there is any problem.
Pictures	

1/ 27 (Day 12)

Mechanical Team	
Progress	We changed the system that can change the elevation angle. The old version is connected from gear to gear, which will lose energy. The new version connected the gear to the aluminum square tube, this will omit the gear-to-gear system and save energy. This also can make the system more stable because of stronger torque and energy.
Problems	Although our torque is strong enough to lift the shooting system, it is not stable enough.
Solutions & Future Plans	We're focusing on adjusting the relative size ratio of the gears in the gearbox. By doing so, we aim to strengthen torque output, thereby fortifying the entire system against potential instability. This strategic modification promises to improve the overall performance of our shooter, ensuring greater reliability and accuracy in its operation.
Pictures	

1/ 28 (Day 13)

Mechanical Team	
Progress	The mechanical team conducted a series of comprehensive tests to evaluate the transition process from the intake to the shooter. These tests involved varying the power levels and angles at which the transition occurred, allowing us to assess the system's performance under different conditions.
Problems	The intake system was found to have gaps along its structure, creating points where notes taken in could become lodged during transit, thereby impeding the smooth flow of materials through the system.
Design Team	
Progress	Design changes were made on the intake, to improve upon the efficiency and rate of note uptake, and reduce the resistance caused by asymmetrical rubber wheels that resulted in faulty uptake and interrupted transference from intake to the turret and shooter system. Specifically, we introduced a more compact design to maximize note contact, increasing stability.
Problems	The intake system was found to have gaps along its structure, creating points where notes taken in could become lodged during transit, thereby impeding the smooth flow of materials through the system.
Solutions & Future Plans	To prevent notes from getting stuck in transit, we aim to devise a more compact structure that increases support for the notes within the intake system. This design modification will ensure smoother material flow and enhance overall efficiency.

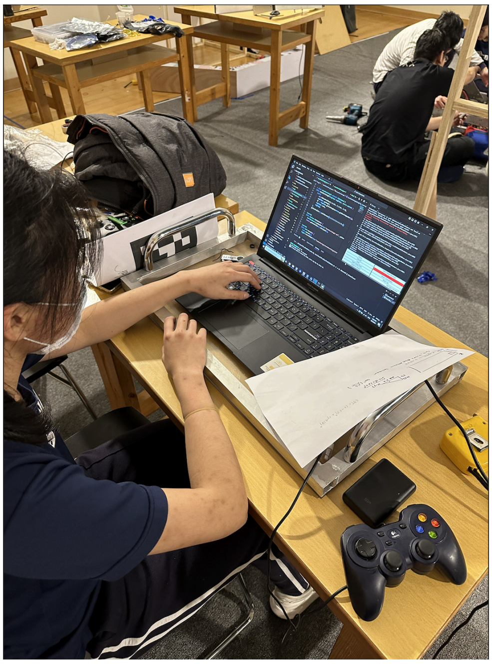
1/ 29 (Day 14)

Mechanical Group	
Progress	We experimented with different designs for the intake, altering the type of wheels used and adjusting their placement and spacing. Additionally, we developed a new prototype for the shooter and intake systems aimed at maximizing the utilization of motor power while ensuring stable movement throughout the process. These adjustments are intended to enhance the efficiency and effectiveness of our mechanisms, improving overall performance.
Problems	The structure exhibited instability during testing, particularly when evaluating the intake functionality. As a result, it collapsed or fell apart under the applied stress. This instability highlighted the need for structural reinforcement or redesign to ensure the system's stability and durability during operation..
Solutions & Future Plans	We are planning to create a new board for both the shooter and intake components. This new design will incorporate a larger structure with strategically placed additional holes to provide better support for the axis. The goal of this redesign is to improve stability and reliability within the system, resulting in smoother operation and overall enhanced performance.
Pictures	

1/ 30 (Day 15)

Design Team	
Progress	We diligently persisted in advancing the development of the bumper assembly by directing our efforts towards the completion of the counterpart section. This segment is designed to seamlessly integrate with the existing half, ensuring comprehensive coverage along the side profile of our robot. Through methodical craftsmanship and meticulous attention to detail, we aim to achieve a cohesive and robust structure that enhances the protective capabilities of our robot's exterior.
Problems	As we progress through today's tasks, we have encountered relatively few significant challenges in the construction of the machine's main components. However, a notable issue concerning the thickness of our bumper material arose. This inconsistency in thickness posed an unexpected obstacle, particularly when attempting to stitch the bumper using the sewing machine. The excessive thickness strained the threads, leading to frequent breakages and disruptions in the sewing process..
Solutions & Future Plans	Our plan entails procuring a set of new needles specifically designed to accommodate the thicker material of our bumper. . By implementing these adjustments to our equipment and materials, we aim to mitigate the recurring problem of thread breakage and ensure smoother progress in the construction of our bumper assembly.
Pictures	 

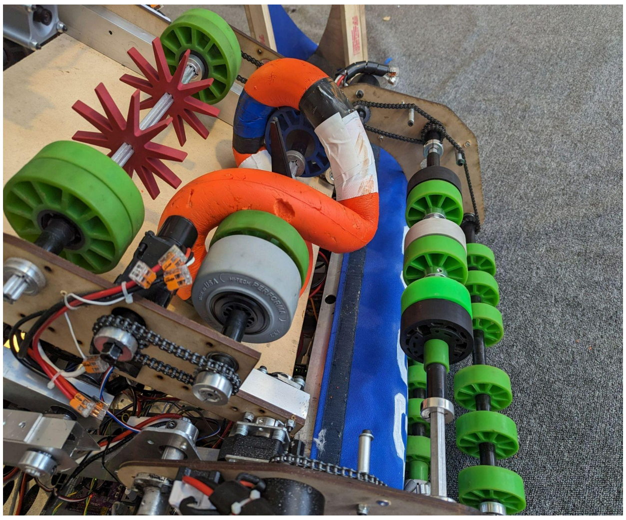
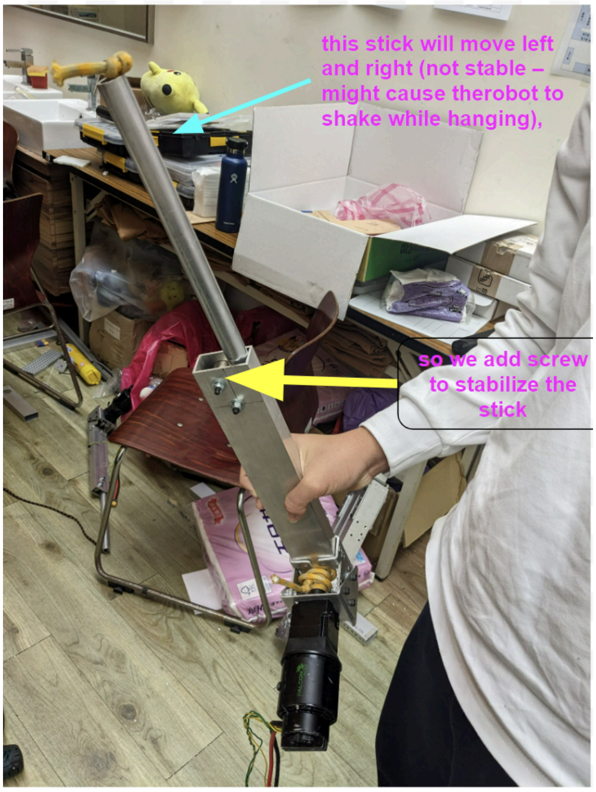
1/ 31 (Day 16)

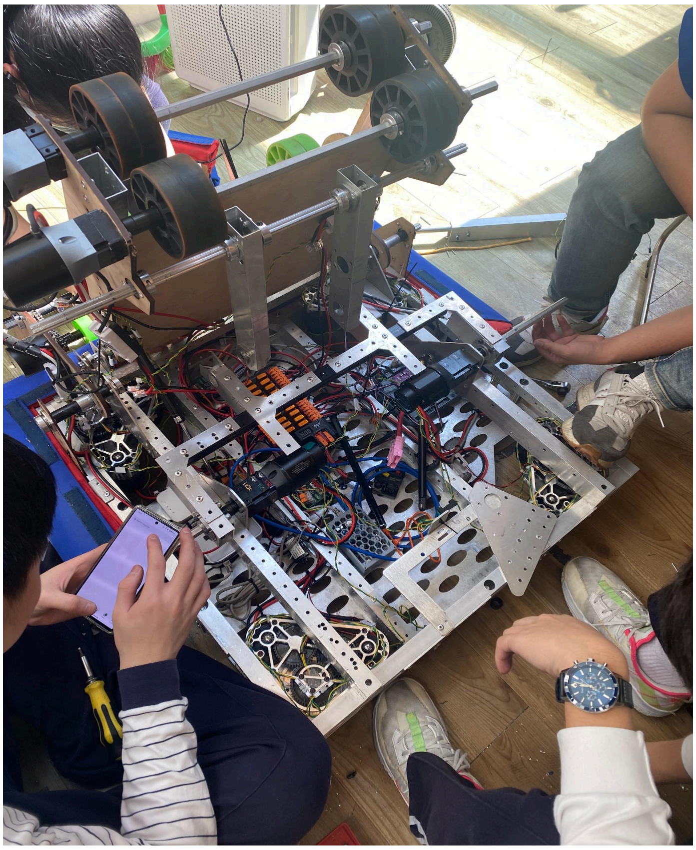
Programing Team	
Progress	Today, all the April Tags for robot localization were meticulously affixed, ensuring seamless identification and tracking throughout the competition. The robots, meticulously assembled with precision and care, were transported to the practice venue where teams eagerly began rigorous testing and fine-tuning their creations.
Problems	Upon conducting meticulous testing procedures, it became evident that our initial assessment revealed inaccuracies in the calculation of the trigonometric functions. Specifically, this miscalculation led to deviations in the shooter's elevation angle, rendering it imprecise and potentially compromising the effectiveness of our aiming mechanism.
Solutions & Future Plans	We will conduct a thorough recalibration of the trigonometric functions within the system, aiming to enhance precision and reliability in angle calculations. Subsequently, we will modify the robot's programming to incorporate these refined functions, thereby optimizing control over its movements. This adjustment will afford us a broader range of options and greater flexibility in maneuvering the robot during the upcoming competition.
Pictures	

2/ 1 (Day 17)

Programing Team	
Progress	Yesterday we discovered an error in our trigonometric calculations and our team is working hard to correct it today. Through careful recalibration and recalculation, we ensured that the trigonometric functions were accurate and reflected the intended shot trajectory. This involves a thorough verification process and double-checking of calculations to reduce the risk of future inaccuracies. In addition, today's test provides us with the opportunity to evaluate the performance of automated lanes in the field.
Problems	After careful calculation, we entered the testing phase to evaluate the functionality of our automatic routing. However, when we encountered unexpected obstacles, glitches and inconsistencies in programming became apparent as we initiated the testing process. These problems arise when our robots attempt to perform predefined actions and sequences autonomously but fail due to errors in program logic. The complexity of actual testing still exposes flaws that went undetected in the early stages of development.
Solutions & Future Plans	Later, we plan to thoroughly review our entire program, focusing on debugging to identify any errors or issues. We will systematically examine each part of the code, employing various debugging techniques to pinpoint any areas that require correction. Our goal is to ensure the program functions correctly and efficiently by addressing any identified issues diligently.
Pictures	 

2/ 2 (Day 18)	
Design Team, Mechanical Team, Programming Team	
Progress	Today our mechanical team is hard at work building a strong suspension system. Meanwhile, another part of our multidisciplinary team is focused on testing the shooting functionality and debugging the accompanying code. Teammates scrutinized every aspect of the shooting mechanics, from projectile speed to ballistic accuracy, to identify any discrepancies or inefficiencies. At the same time, software developers comb through the code base to identify and correct any errors or inconsistencies that could impair system functionality.
Problems	Our team discovered a key issue: the stick used to make contact with the chain exhibited unexpected lateral motion instead of a consistent vertical trajectory. This deviation from the desired motion poses a significant challenge as it introduces uncertainty and instability into the suspension process. Additionally, our testing revealed intermittent differences in the position of the notes within the intake track, similar to the irregularities depicted in the first photo below. This inconsistency poses a huge impediment to seamless operation for shooters, as it compromises the system's ability to reliably acquire and process incoming notes.
Solutions & Future Plans	Our team decided to enhance the functionality and reliability of the shooting system. A key aspect of the plan is the switch to aluminum as the primary material for manufacturing the launch mechanism. , is expected to bring greater stability and flexibility to the system. Additionally, we carefully re-evaluated component placement and alignment to ensure seamless capture and processing of notes. We also introduced screws to stabilize the stick attached to the chain during hanging. This strategic enhancement will prevent unnecessary lateral movement and ensure that the joystick maintains a stable vertical trajectory, promoting reliable and precise suspension of the robot.

Pictures	  this stick will move left and right (not stable – might cause therobot to shake while hanging), so we add screw to stabilize the stick

2/ 3 (Day 19)	
Mechanical Team	
Progress	After carefully examining the existing shooter design, we uncovered a critical flaw: its compact nature left no room for additional hangers to be installed. Recognizing the necessity for accommodating supplementary components, we made the decision to undertake a comprehensive redesign of the shooting mechanism. This overhaul was imperative to ensure the functionality and versatility of the system in various operational contexts.
Problems	Because there is not enough space for the hanger to be installed, we had to make room for the hanger. However, we found that the space we originally planned to install was not enough no matter how we arranged it. If we made room for the hanger, the structure would have to be adjusted. Then we decided to change the placement of the hanger and slightly modify the structure of the machine.
Solutions & Future Plans	In the future, we are going to change the hanger's position and slightly change the shooter's position to make enough space for the hanger to fit.
Pictures	

2/ 4 (Day 20)

Programming	
Progress	We recently integrated a camera into our machines specifically for detecting AprilTags with PhotonVision. Once the camera captures the AprilTag, our co-processor Orange Pi 5 processes the data with Multi-Target tracking to produce an accurate robot pose, which we can then use to calibrate the robot's location. Having the robot pose means that we can now accurately calculate the angle required to shoot into the speaker.
Problems	● AprilTag detection is inconsistent at long ranges ● The ideal angle calculation is inconsistent with real results
Solutions & Future Plans	We reconducted camera calibration, which helped the first issue, but did not resolve it. We will continue to tune the blur of the image to obtain a less noisy result. We will conduct experiments to see at what angle the speaker is supposed to be oriented at in order for it to shoot accurately into the speaker. With those datapoints into an excel sheet, we can export a distance-angle graph, which we can then plug in to the angle setpoint in our codebase.

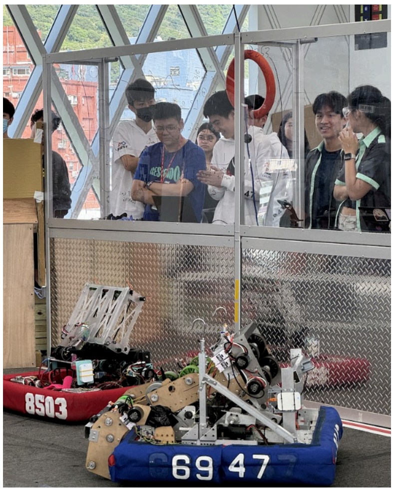
2/ 5 (Day 21)

Mechanical Team	
Progress	Following yesterday's work, today the testing phase of our newly developed machine begins. After the construction was successfully completed yesterday, we started installing the hangers. The testing process begins with a thorough inspection of each machine. During our installation we discovered some issues with the hangers. In the end, we decided to modify the entire hanger structure and make a new one.
Problems	During the process of redoing the hanger, we discovered a serious situation, that is, only half of our bearings could be refitted into our aluminum square tubes. At first, we thought that our aluminum square tubes were too big. As a result, when we went to the factory and showed it to their staff, they said the problem was with the bearing. Half of our bearings have been adjusted internally so that they can be successfully inserted into the aluminum square tube, while half have not been adjusted and therefore cannot be inserted into the aluminum square tube.Finally decided to group the materials and group each bearing with the tube. And select the size of the aluminum square tube to make it fit the bearings.
Solutions & Future Plans	After what happened today, we decided to purchase materials directly from Taiwan next year. Since this year's materials were almost all purchased in the United States after last year's competition, and the bearing specifications in the United States are different from those in Taiwan, the factory in Taiwan was unable to help us immediately after the problem occurred. In the end, we decided to just purchase the materials for next year directly from Taiwan.
Pictures	 

LUNAR NEW YEAR

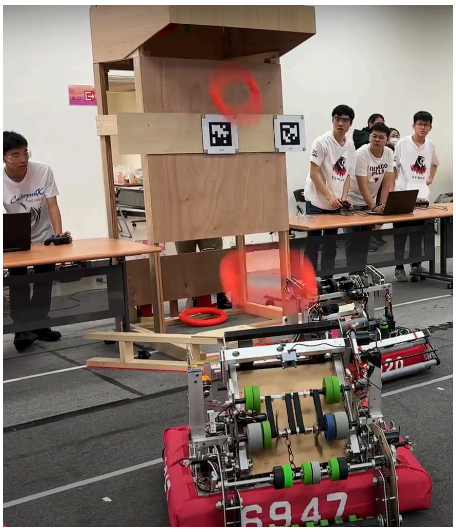
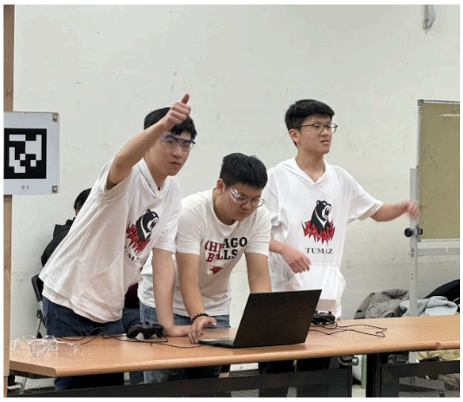
2/ 23 RAID ZERO (FRC#4253) PRACTICE SCRIMMAGE

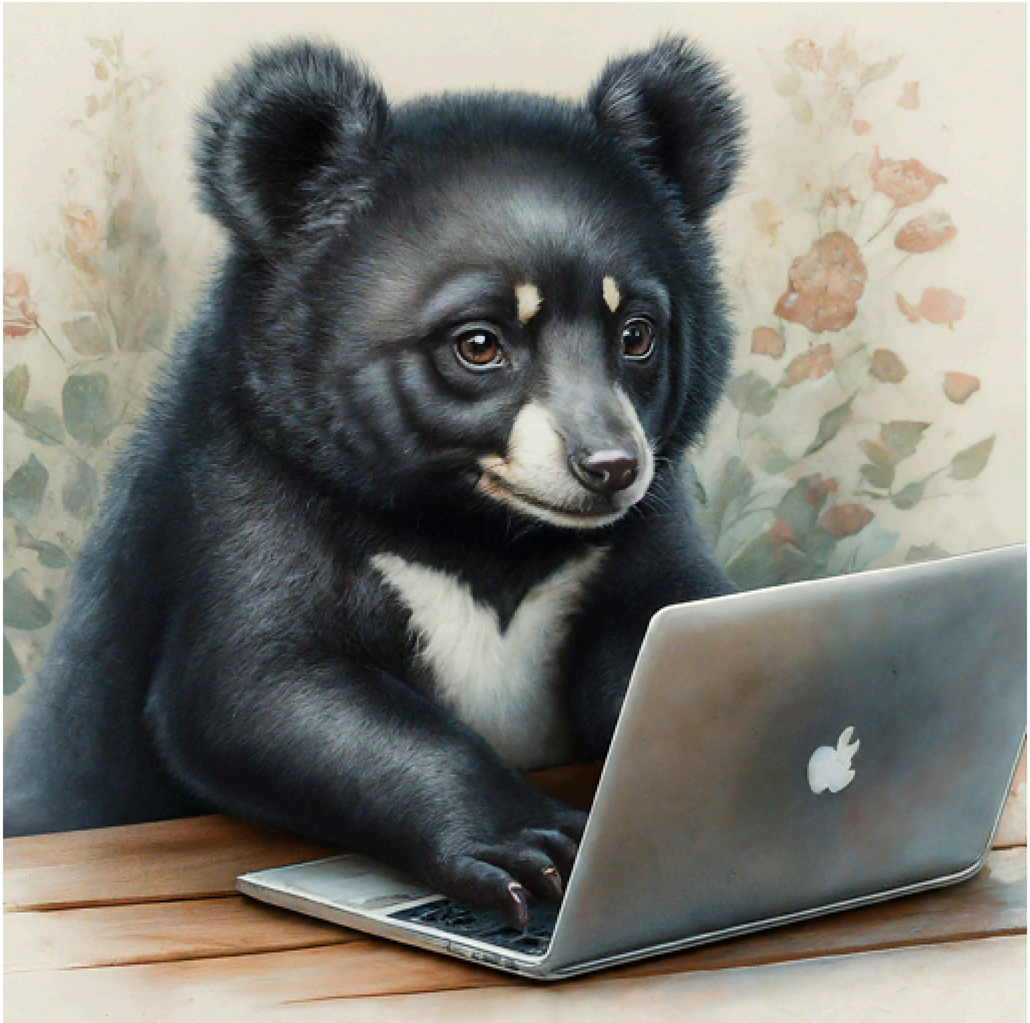
Drive Team + Mechanical Team	
Progress	Prior to today’s match, our team had prepared our robot for the upcoming scrimmage. We conducted testing within the limited confines of our school's practice area, focusing primarily on coding for the autonomous segment on the blue side of the field. Despite the spatial constraints, we managed to refine our robot's movements and algorithms, laying a foundation for success. Additionally, we were forced to upgrade our intake arm from fiberboard to metal because of the destruction of our original intake claws. This enhanced the new intake claws’ durability and functionality. These efforts reflected our commitment to thorough preparation and improvement, positioning us well for the challenges ahead.
Problems	However, during the scrimmage, a series of unforeseen challenges emerged, highlighting gaps in our preparation and strategy. Due to oversight and inexperience, we neglected to adjust the autonomous program to account for our team's color, resulting in a collision with the wall that damaged the intake claws. This setback compounded when our semi-autonomous program malfunctioned, causing the robot to navigate beneath the stage while raising its arm, ultimately breaking the angle adjusting arm. These incidents underscored the importance of comprehensive testing and adaptability, revealing areas for refinement in our approach.
Solutions & Future Plans	Despite setbacks, today's competition provided valuable lessons and insights that will inform our future efforts. Moving forward, we are committed to implementing robust testing protocols to account for various scenarios and environments. Additionally, we will prioritize flexibility in our coding and strategies, ensuring that our robot can adapt seamlessly to changing conditions. To address the damage incurred, we will repair and reinforce critical components while exploring innovative solutions to enhance resilience. While today's challenges may have delayed our progress, they have also galvanized our determination to overcome obstacles and succeed in upcoming scrimmages and competitions.

Pictures	  

2/ 24 CyberpunK (FRC#8020) PRACTICE SCRIMMAGE

Drive Team + Mechanical Team	
Progress	Today, the drive team worked on coordinating with each other to smoothen the process of taking in game pieces. We planned to use minimal hand signals, as they were ineffective from today's practice and also from past year experiences. Instead, the human player at the source developed a technique of spinning the note as it dropped to the ground so that it would stay where it lands and not roll around. One of the drivers would then keep their eyes on the color sensor and camera on the screen to make sure the note is in intake range and that it is successfully taken into the Mid Intake transport system afterwards. Developing these communications will be important in the actual competition, as synchronization and team synergy are just as important as the functionality of the robot.
Problems	A major problem that we encountered today with our robot was that the wheels of the shooter kept falling off. We didn't know why this kept happening, but it was starting to interfere with the robot's shooting ability, so it had to be fixed. The intake also had problems while transferring the notes into the transport system, with the turning speed not being synchronized and the intake not having enough power to take notes in.
Solutions & Future Plans	To solve the problem of the wheels coming loose, we used strong glue to stick the wheels more firmly together than before, while also restabilizing them to decrease the possibility of them coming off in the future. We still do not know why they fell off, but at least now we have one more thing to make sure works before each time we are about to get on the field for a competition. To solve the problem of the intake not having enough power, we tied intake rods to the transport system so that they could be assisted by the transport system's power. This was a viable solution for now, but it also made maintaining the robot harder, as these cable ties that assisted the intake claws had to be replaced after every match because of how weak they were. But until we find a more viable way to fix this problem, we will be sticking to this solution.

Pictures	 
Programming Team	
Progress	After fixing the intake claws that broke off yesterday and replacing them with metal components, today's scrimmage went a lot better than yesterday. After not being able to test our autonomous performance yesterday due to our intake claws breaking off, we were finally able to do some testing on both blue and red alliances today. Today, we were able to score the preloaded note and pick up two more notes to score from the starting position close to the amplifier on both the blue and red side. After the scrimmages, we also worked on testing the PID of the robot's path finding to make sure that it landed in the same spot every time. We did this because we realized that even though the angle of the shooters was the same, our robot had trouble scoring notes sometimes while autonomously aiming using the april tags. After fine-tuning the PID of the robot's pathfinding to make sure that it landed on the same position nearly every time, we started testing the angle at which our robot should shoot for the note to enter the trap. After multiple tests, we still couldn't get the note to go into the trap without it bouncing off the flap.



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