FTC#9929
Tech Ninja Team

Engineering Portfolio

2023-2024

Team Overview

Hello! We are Tech Ninja Team (TNT) FTC#9929, a community team from Homewood-Flossmoor, Illinois.

We work out of an old funeral home which is now the Homewood Science Center. Our workshop is in the garage where they used to park the hearses!

Though our Tech Ninja Team has been operating for 10 years, several of our older team members have recently graduated high school and have gone off to college. That made 2023-24 a season of firsts and learning new skills for us.

New things we learned this year:

Surendran
Learned programming

Marcus
How to sketch more in CAD

Ezra
Learned how to use CAD

Leith
Learned how to use calipers

Ian
I'm new this year!
Worked on drone laucher

Trevor

Kammi

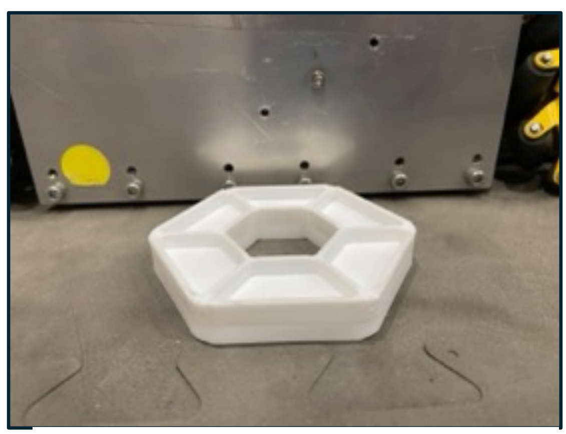
Drive Base

Our drive base has mecanum wheels because it allows our robot to move in any direction.

This bumper prevents pixels from getting stuck under the wheels

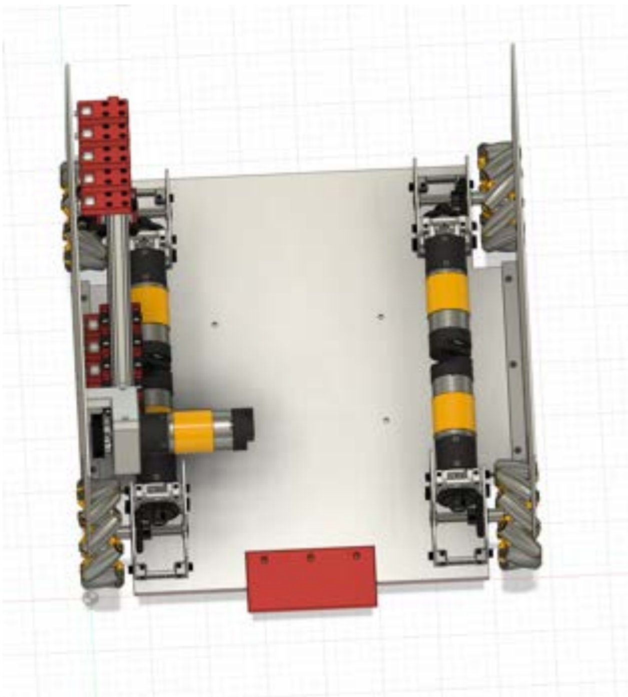
DESIGN

During one of our league meets, the control hub slammed into the rigging and disabled the robot. We added this Lexan shield at the front to prevent this, which also adds stiffness to the drive base.

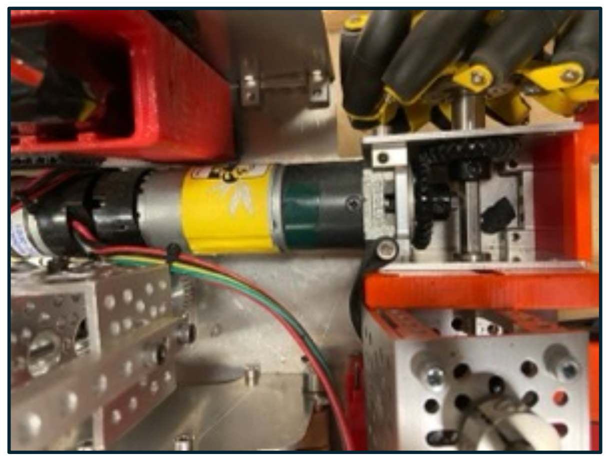


The drive base is low to the ground to prevent stuck pixels.

Drive Base



The motors are mounted low to create a low center of gravity. There is also more space in the middle of the robot.



- Throttle curves when driving the robot for precision and speed.
- One button inverse of driving controls makes it easier to operate when robot is heading towards the driver.
- LEDs change color to indicate alliance configuration for auto, time warning for end game, and in end game.

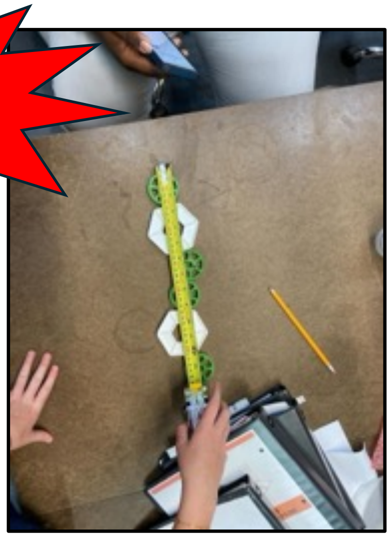
- Controllers rumble to signal end-game - team can focus on robot and the game.

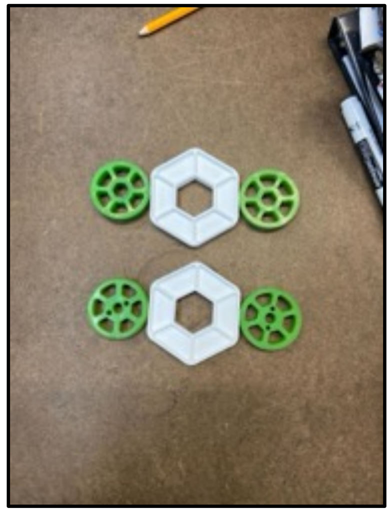
Controls

Intake Mechanism

How it works: The pixels are picked up from the intake wheels at first. Then the pixels are moved to a conveyor belt mechanism. The pixels are then moved up the conveyor belt to the bucket. The bucket is attached to the lift. The lift raises the bucket. The movement of the pixel within the robot happens while driving. This leaves less room for error and doesn't require turning the robot around to score the pixel.

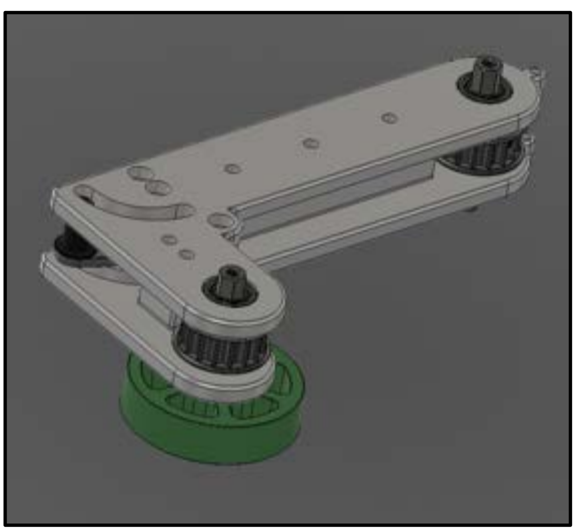
STRATEGIZE





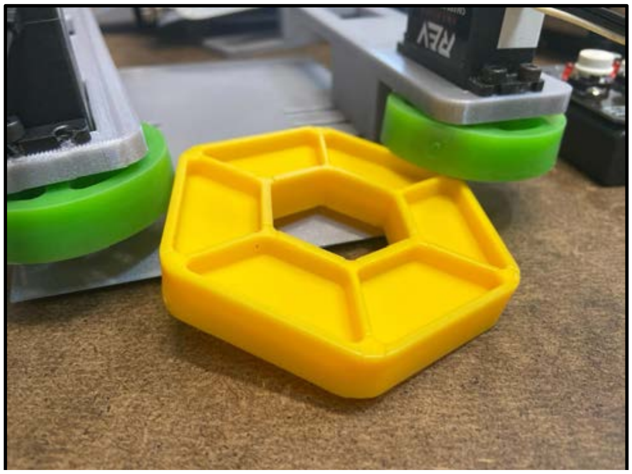
These are the two possible ways our team came up with for intaking pixels. The first picture shows our design for bringing in two pixels at once. This configuration **took too much space**. It would be good only in a few scenarios, and it would be harder to get the pixels in the bucket we use to score pixels. The second configuration saves space. The idea was to use one set of wheels to bring in the pixel and the second set of wheels to transport it back to our bucket.

THINK



This "hook" piece was designed in CAD. There is a hole on the end that was meant for making the mechanism push onto the pixel and pull the pixel in easier. At the bend, there is a tensioner that is able to move when it hasn't been tightened with screws. Its purpose was for allowing the belt to be as tight as we need it.

We found that this mechanism would push pixels away if it hits them in certain ways. We didn't use these hooks after deciding on a different method.

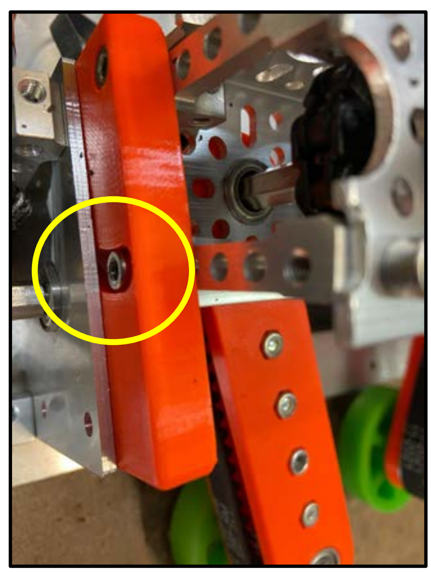


This was our original intake that was designed in CAD. It didn't work in practice because the wheels were too high up. The pixels wouldn't make it up the ramp with this build, or they would get stuck under the ramp.

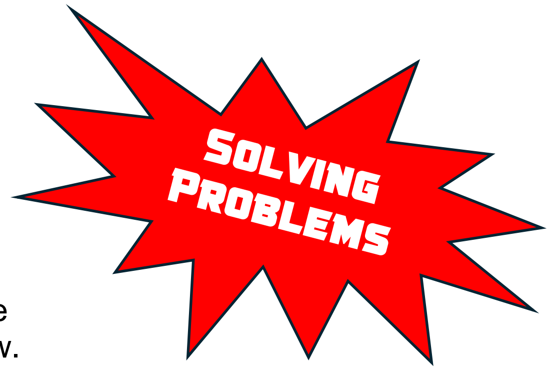
We used servos for the first intake design and quickly found we needed a lot more power to bring the pixels up the ramp. The servos didn't spin the wheels fast enough.

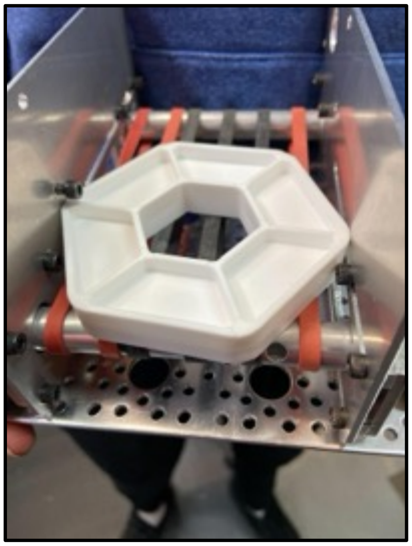
DESIGN

The motors were installed vertically so we have more space for other parts of the intake mechanism.

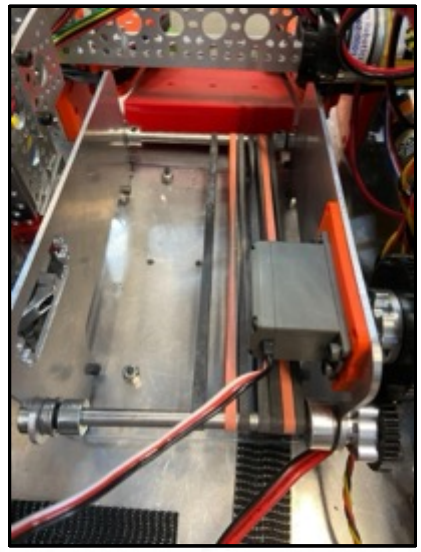


The larger orange piece fills the gap between the intake mechanism and the robot wheel and allows for adjustment.   This set screw is used to lock the intake piece at the correct angle.





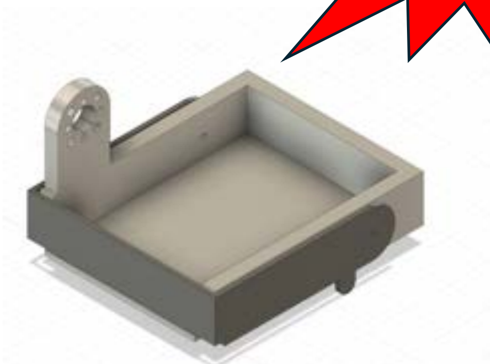
The pixels were getting stuck if they turned. The pathway was too narrow.

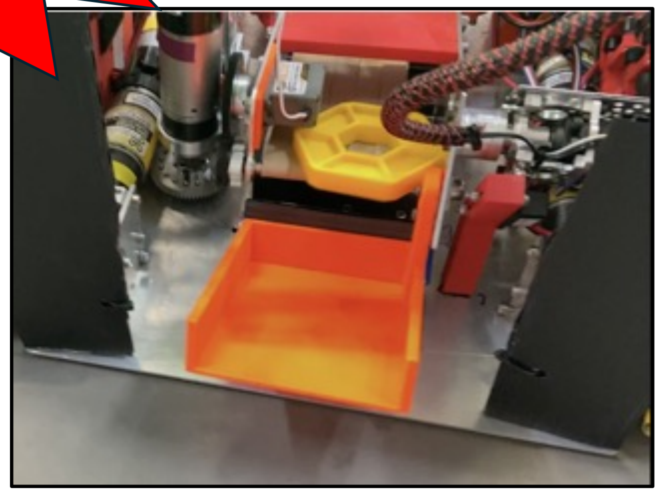


We use rubber bands on the conveyor belt that moves the pixels from intake to our bucket. The long rubber bands shown here weren't durable, so we had to keep replacing them. Our new design uses shorter, fatter rubber bands that don't break as often and aren't as hard to adjust or change.

An early prototype had squishy green wheels that gripped onto pixels easily, but the pixels often weren't intaking correctly with those wheels. They were getting lifted up and came in at the wrong angle. We changed them out for these firmer blue wheels that give more reliable results.

INNOVATE





We put the bucket at an angle and used a cardboard piece to prevent the pixels from getting stuck between the conveyor and the bucket. Without these features, the pixel would get stuck under the bucket, and we wouldn't be able to score without removing the stuck pixels from the robot.

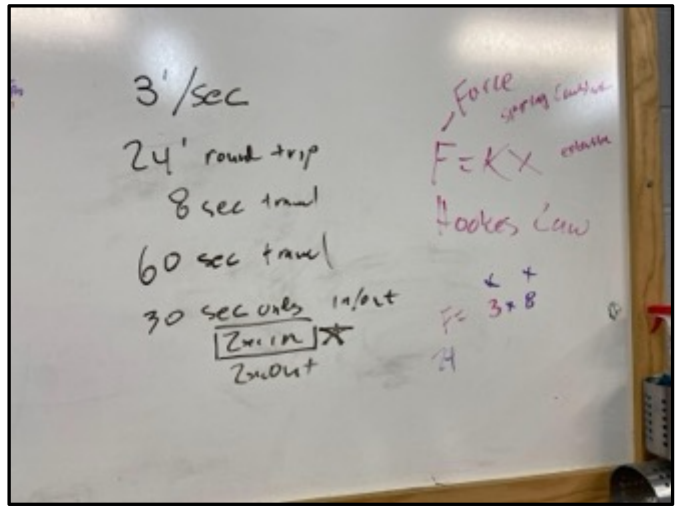
The biggest problem we had to solve was how to get the pixels from intake to the bucket. The conveyor started with a large amount of thin rubber bands that would break easily. We decided instead to use large rubber bands, which decreased the number of rubber bands needed and made it easier for the conveyor to take in pixels.

A problem we still have is that sometimes the pixel doesn't get hooked/locked onto the conveyor after the intake mechanism pulls it into the robot.

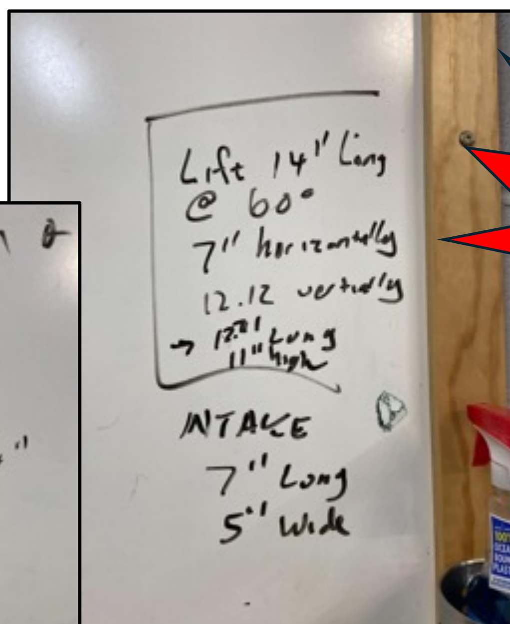
CONTROLS

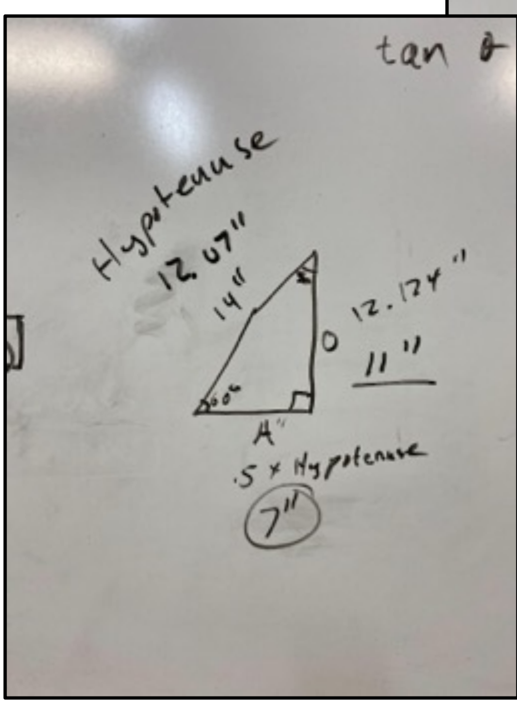
- Prevent intake of pixels when the scoring mechanism is out of place to receive them (prevents penalties).
- Speed control when intake is putting pixels back on the field to avoid penalties.
- Automatic extension and retraction of the scoring mechanism, including positioning the pixel bucket correctly when lift is at the bottom, when traveling up/down and when scoring against the backdrop.

Scoring Mechanism

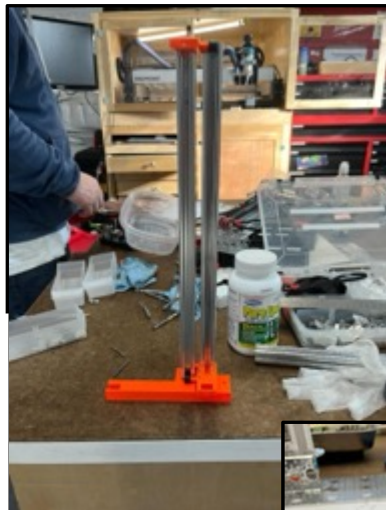


Pixels are located across the field so speed is very important. The total speed of the intake, driving, and delivery to the backdrop had to be considered.
These calculations show how much we can achieve within a two-minute time limit.





Doing the Math
The lift is used to place pixels on the backdrop which is slanted. In order for our lift to reach the top of the backdrop, not only does it have to be slanted, but it has to be as tall if not taller to allow us to score as pixels (or points) as possible.

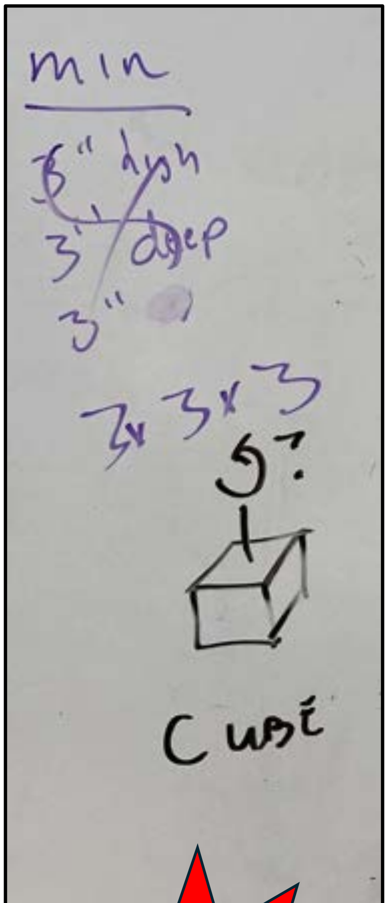


Prototype
This is a prototype of the lift. The orange piece is the prototype motor/belt attachment part for the lift. The markings show the things needing to change and notes for the new Fusion 360 model for the final design for this part of the lift.

Final Design Decisions
We decided to use a belt lift instead of a chain lift as used in Skystone. Belt lifts are lighter than chain lifts since there are fewer parts and heavy materials weighing them down. We decided from the beginning of the season that we were going to try to maximize how big our robot could be based on the amount of mechanisms necessary to complete all the challenges. All those mechanisms add weight to the robot, so we needed to use a lighter lift. The belt is also in one piece, and so it is easier to repair. It is also easier to make adjustments to a belt lift.

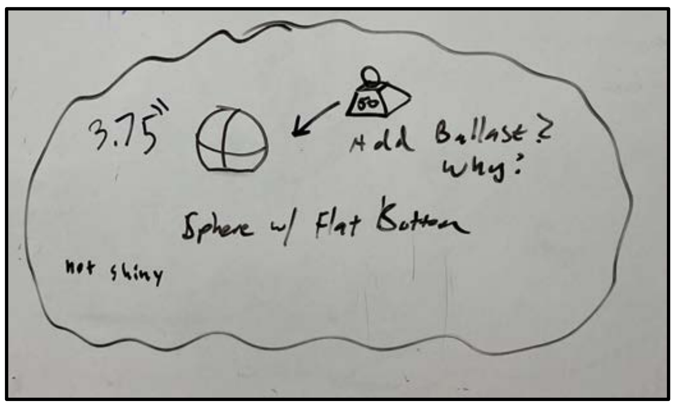
Team Scoring Element and Computer Vision

STRATEGIZE



The minimum dimension of the scoring element can be 3X3X3 inches and the maximum can be 4X4X4 inches.

A cube can be placed in a way that the robot can't detect it. A square can look different, depending on the angle of placement, but a sphere will look the same no matter how it's placed.

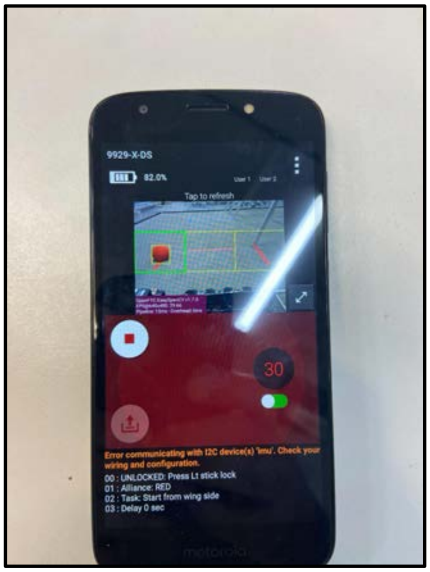


THINK

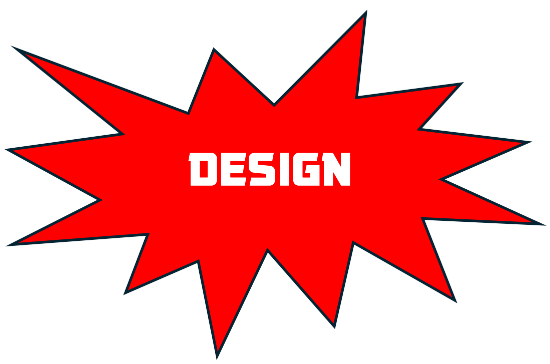
We decided on a sphere with a flat bottom for our team scoring element because the robot can detect the prop any way we place it since the sphere has the same sides from any angle.

We made our prop 3.75" in diameter in order to make it as large as possible for detection by the robot without going over the 4" maximum size. This also it leaves room for measurement error.

We made the element out of a non-shiny material. The robot can detect the color under different lighting conditions as long as the prop is not shiny. If the prop were shiny, the robot might not recognize the color.



In the pictures above, the robot is detecting the color and size of the object. There are three “zones” where the robot can expect to find the prop. After detection the robot places the pixel on the line where the prop is. The detection zones are larger than the team prop because that way we can be sure to detect the object and the line where the pixel should be placed. The zones cover right in front of the robot and not too far up the field because the robot can see the object more clearly and detect it easily.



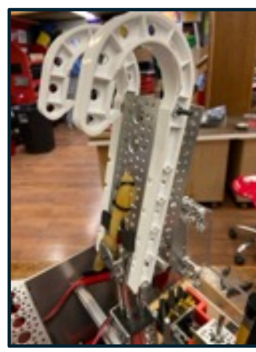
Hanging Mechanism

Option	Points	Probabillity	Time (sec)	Probable Points	Efficiency (pts/sec)
Robot Location: Robot Suspended from Rigging	20	0.95	10	19	1.9
Robot Location: Robot Parked In the Backstage	5	1	8	5	0.625
Drone Launch - Zone 1	30	0.25	10	7.5	0.75
Drone Launch - Zone 2	20	0.3	10	6	0.6
Drone Launch - Zone 3	10	0.5	10	5	0.5
Special Conditions					
Preloads: Purple and Yellow Pixel					
What can be done when/from where?					

STRATEGIZE

We decided to get a hanging mechanism into the robot quickly because the hanging mechanism was the most efficient way to get points. It is easier to control the robot than to control how the drone flies. Our drone launcher was not consistent enough to rely on to make points.

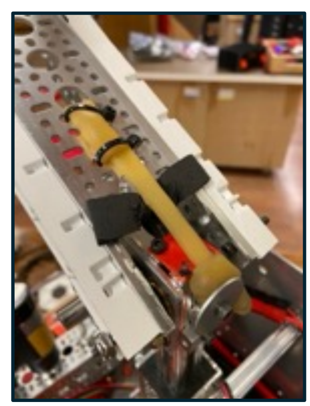
At first we thought we'd need a locking mechanism like this carabiner to keep the robot stable on the bar. We got rid of it because it required too much pressure to open the carabiner.



DESIGN

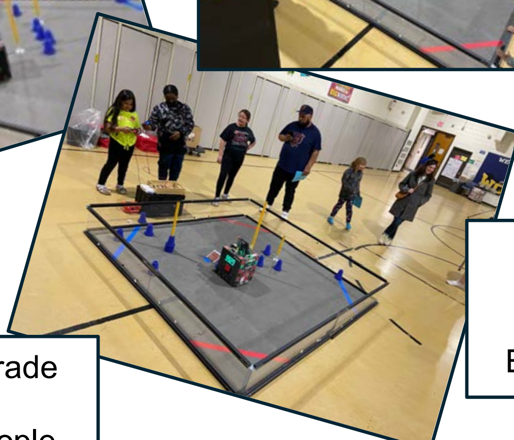
The hanging mechanism needs to fold to save space. We use a motor to raise it up and surgical tubing as a spring to make it unfold.

We use a lead screw for the hanging mechanism so gravity doesn't pull the robot down when it is hanging and when the motor stops receiving power.



Outreach - Community

Girls STEAM Ahead Function
Date: March, 2023
Estimated reach: 70 female students 6th-12th grade



Western Avenue School
STEAM Night
Date: April, 2023
Estimated reach: 120 people

Homewood 4th of July Parade
Date:July, 2023
Estimated reach: 800 people

Sponsorship and sustainability

This season we were fortunate to once again be awarded a grant from Schneider Electric.

The Homewood Science Center has been invaluable to us for many seasons. They provide us with space to work and have introduced us to our two sponsors. We give back by volunteering at their events, which in turn helps us with STEM outreach.

The Tech Ninja Team tends to recruit new members through our sister FLL teams. Ian is a new team member this year and has participated previously in FLL.