Engineering Portfolio

Team Fibonacci 14126

Springfield, OR

Our mission is to increase our knowledge in every aspect of robotics by observing and hands-on learning. To grow in our ability to adapt and learn in difficult situations, and to utilize our ever-growing knowledge and community to spread the benefits of FIRST

Table Of Contents

Full Team Plan

Our team is split into 3 subgroups: *engineering, code, and business*. At the beginning of the year each group sat down and **wrote a list of goals** they wanted to complete this season **along with the steps we needed to take to complete them**. After each competition we make even smaller goals we want to have completed before we compete again. **This keeps us focused and productive**.

Sub Team	Goals	Plan to reach our goal
Engineering	1. Move away from shelf parts and towards custom parts	Use less OTS parts on robot→ reach out to our sponsors about using waterjet→ use 3D printer, CNC machine, chop saw, table saw, and drill press to make parts
	2. CAD our robot and fully optimize it	Learn SOLIDWORKS→ CAD prototype robot→build optimized version of robot in CAD.
Business	1. Further our outreach into the technical community	Explore our connections → reach out to businesses by call and email → create a script for presentations
	2. Learn how to notebook efficiently as well as build a good portfolio	Talk to business captain alumni → explore formatting options → organize into sections → assign parts to team members → hold occasional meetings specifically for notebooking
Coding	1. Re write and build our base code	Look at last year's code → write gyro code for driving → build drive functions for efficiency
	2. Build a consistent and full point autonomous	Learn camera detection → look into roadrunner/odometry → find a way to navigate the stack quickly → build 4 different autos

Meet The Team

Solomon (18)	Chase (17)	Dennis (17)	Tasha (15)
			
Years in FIRST - 6 Role: Lead Coder	Years in FIRST - 1 Role: Engineer	Years in FIRST - 7 Role: Co-Captain	Years in FIRST - 7 Role: Co-Captain

Micah (15)	Kennice (15)	Aspen (15)	Abby (14)
			
Years in FIRST - 4 Role: Engineer	Years in FIRST - 1 Role: Coder + Business	Years in FIRST - 1 Role: Business	Years in FIRST - 6 Role: Lead Business

Finn (14)	Khrom (13)	Max (13)	Riah (12)
			
Years in FIRST - 1 Role: Coder	Years in FIRST - 1 Role: Engineer	Years in FIRST - 1 Role: Engineer	Years in FIRST - 1 Role: Engineer

Sustainability Plan

Our team is never short of members. We gain a good amount of members through our annual **workshops and outreach events**. We also have **3 FLL teams in Springfield Robotics Club that feed into Fibonacci**. Additionally, this year we held an **open house at our meeting space** to attract members.

Business Team Plan

Lead: Abby
Support: Kennice, Aspen, Tasha

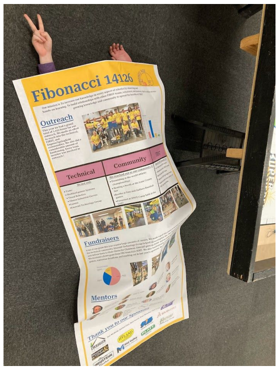
Individual goals

Abby		Kennice	
Goal	Accomplishment	Goal	Accomplishment
Learn how to manage a team	Led the Business sub-group and managed full team meetings	Be more professional	Presented to multiple different companies

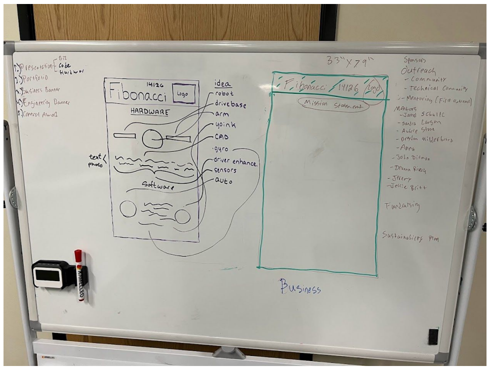
Tasha		Aspen	
Goal	Accomplishment	Goal	Accomplishment
Learn how to format and develop a good portfolio	Researched different FTC portfolios and manage the building of the portfolio	Learn and grow in her ability to manage	Managed the notebook and wrote agendas for full team meetings

Banners

We decided to **branch out and design banners for our judging and pits.** We made 2; one for robot and one for outreach. These help us communicate the hard work we've done in judging, outreach events, and presentations.



Test print banner


Planning banner layout

Mentors In Action

- **Aubrie -** notebook, portfolio, management
- **Jenelle** - fundraising, management
- **Alisha** - graphic design, portfolio
- **Deanna** - website
- **Christy** - outreach, fundraising

Promote Video

Last year was the first time we explored the promote video. This year we decided to do a stop motion with 3D printed snails in a news report fashion**. We learned a lot about editing, stop motion, audio recording, and video production.**

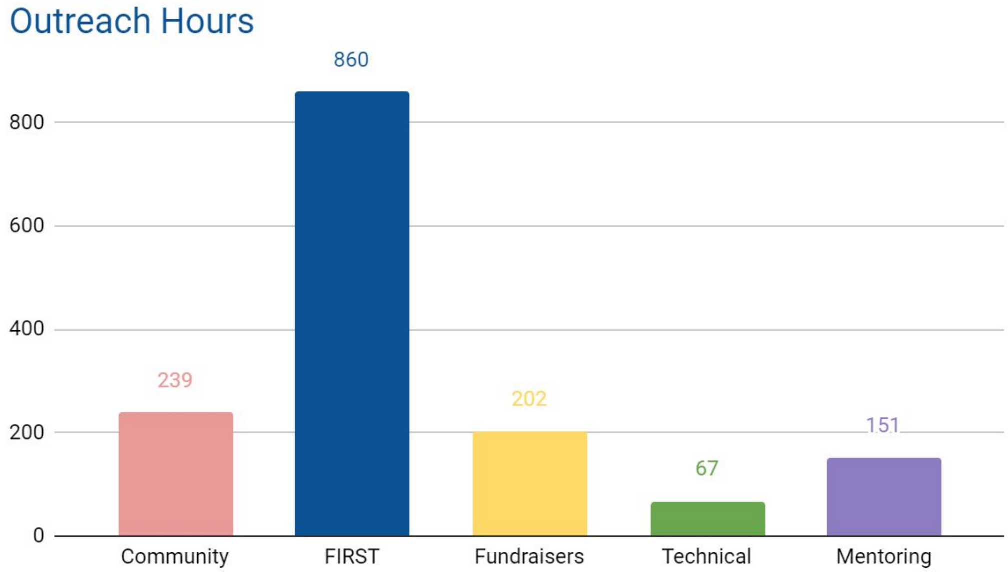

3D printed snails for the promote video

Filming the promote video

Motivate/Connect

OUTREACH

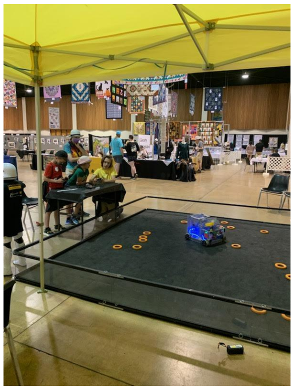
This year we spent **1519 hours** reaching out as a team! We split our outreach into 4 different categories: *Community*, *Technical*, *FIRST*, and *Mentoring*. Our favorite outreach event was getting **invited by Dean Kamen** to present at the World's Athletic Championship!



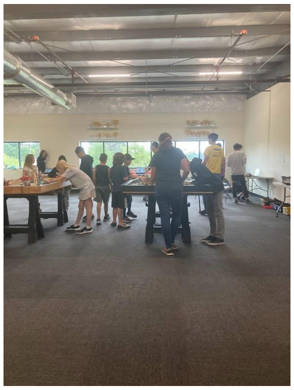
Community Outreach (239 hours)

Booth at Lights of Liberty

Presentation at the World Athletics Championship!



Booth at the Lane County Fair



Lego robotics workshop

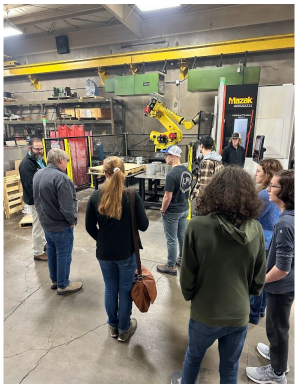
Booth at the EMS for STEAM night!

Table at the U of O for a girls STEAM camp

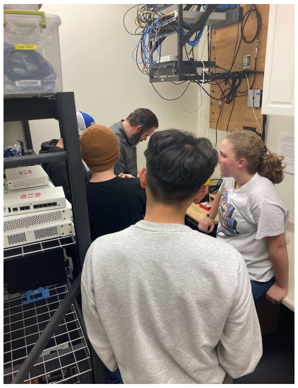
Booth at a Drifters baseball game

Volunteering at Food for Lane County

Technical Outreach (67 hours)



Touring Tumc



Touring Emerald Technology Group

Touring Pak Tech

Touring Olsson

Touring Stoddard

Touring Visual Robotics

Meeting with Garmin

FIRST Outreach (860 hours)

Co-hosting an FLL tournament

Co-hosting all of our league's events

Volunteering at multiple FTC events

Volunteering at multiple FLL tournaments

Mentoring (151 hours)

Fibonacci got the chance to mentor 7 different FTC teams! We also mentored 2 FLL teams and one of our members was the robot coach for another FLL team. This totalled to the **mentorship of 9 different teams** in the FIRST program!

Meeting with 2 FTC teams

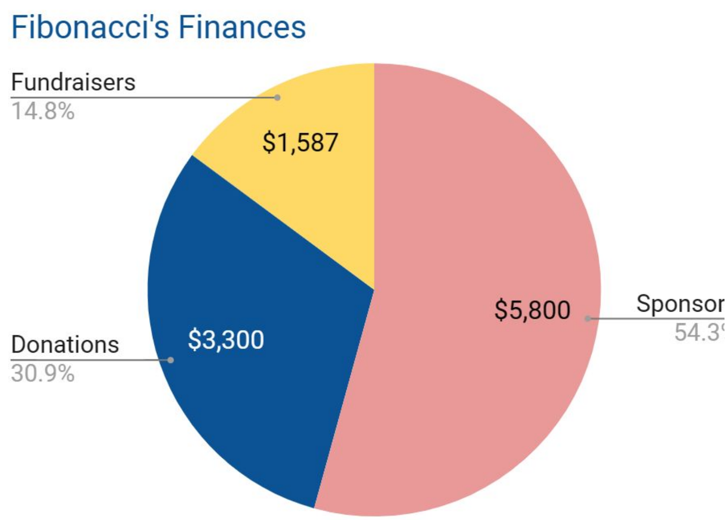
Mentoring FLL teams

FUNDRAISING

Our goals this year required large amounts of money. We made a goal this season to increase our fundraising within the technical community. Emerald Technology Group helped us accomplish this. They hired us to bake 250 cinnamon rolls and deliver them to their clients for Christmas. **Emerald gave us $1000 and we made an additional $2148 from donations!** We received a **$1000 grant from FRC team 2521 SERT**. We also fundraised by scooping ice cream at the *Ems Baseball games, numerous donations, and reaching out to last year's sponsors*. We raised **a grand total of $10,687!**

Us receiving our grant from FRC team 2521

Our big cinnamon roll fundraiser



MENTORS

In previous years our team has sorely lacked in mentor recruitment. We decided to fix that. We **enlisted mentors through personal connections, writing letters, and our technical outreach.** Our main **mentor focus was on CAD and outreach.** However, we also recruited mentors for code, notebooking/portfolio, and engineering.


Alisha Langan
Fibonacci Coach


Danny Diaz
FIRST


Sandra Langan
Fibonacci Alumni


Jenelle Hahn
Fibonacci Coach


Jarrod Schutle
Garmin, 3D printing CAD


Aubrie Stone
Fibonacci Alumni


Jessie Britt
OS Engineering, CAD


James Langan
Fibonacci Coach


John Dillman
DWFrtizt, CAD


Mike Hahn
UofO Bowerman Sports Science Clinic, Outreach

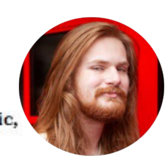

Nathan Stone
Emerald Technology group, Business


Deanna Rivera
Uplink Spyder, Website Development


Jan Hampton
Thurston High school Outreach


Christy Stone
Springfeild Robotics Club, Fundraising / Business


Jeromey Black
Olsson Industrial Electric, Fabrication


Brayden Hilderband
Fibonacci Alumni

Engineering Team Plan

Lead: Dennis
Support: Riah, Chase, Khrom, Micah, Max

Individual Goals

Dennis		Riah	
Goal	Accomplishment	Goal	Accomplishment
learn how to design and produce custom parts to fully optimize our robot	Learned how to optimize a robot with CAD, used CAD to 3D print and waterjet custom parts	get a fundamental understanding of mechanical engineering	Solder and wire and design better battery management

Chase		Khrom	
Goal	Accomplishment	Goal	Accomplishment
create relationships with people who share my interest in robots	joined drive team. got to interact with all the teams we compete with	understand the essentials of mechanical engineering	Learned how the robot works through maintenance & upkeep tasks

Micah		Max	
Goal	Accomplishment	Goal	Accomplishment
Expand on my knowledge of 3D printing as well as my engineering talent	better knowledge of 3d printing mechanics. Built the servo system for the dead wheel lift	learn the basics of mechanical engineering	took over the pre-flight checklist & robot maintenance

Mentors In Action

- **John** - CAD, design, source parts
- **Jared** - 3D printing
- **Jessie** - machining
- **James** - A little bit of everything
- **Jeremy** - machining, fabrication
- **Jan** - tools, encouragement

Riah and Khrom cutting encasement

Dennis learning how to CAD

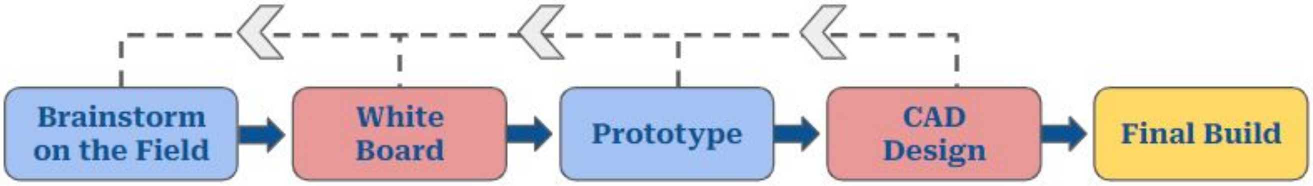
Big Accomplishments

- Increased custom parts
- Efficient prototyping
- Battery system on jeremy (our cart)

Next Steps

- Develop drive base
- Continue to optimize the reach

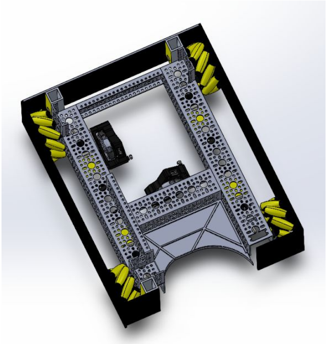
Design Process



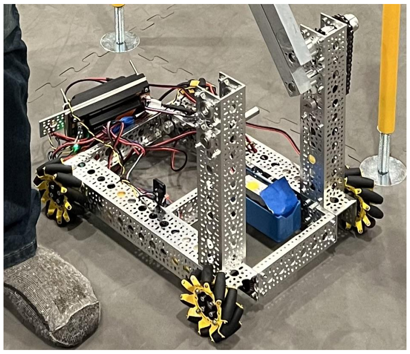
Design

Drive Base

our drive base is **Gobilda strafer chassis modified to be narrower and faster.** For our encasement, we originally started with aluminum/PE composite for our side panels. However, the composite had too much memory, meaning that the aluminum could bend into the wheels and lock them up. Because of this, **we decided to switch to polycarbonate,** which is extremely s**trong and flexible, so it can absorb shock.**

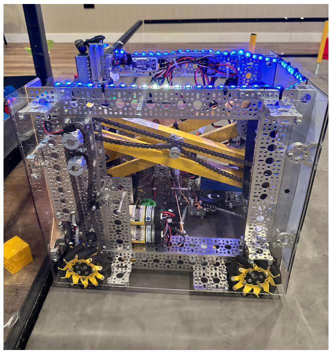


CAD image of our Drive Base

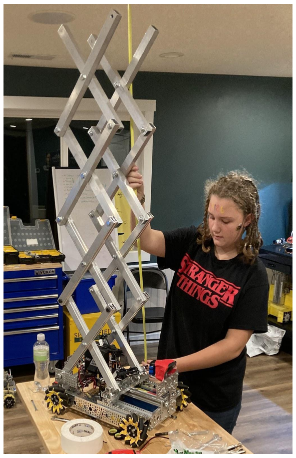


Our initial Drive base (without encasement)

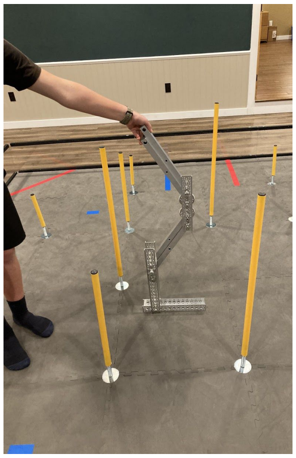
Our original Aluminum/PE composite encasement



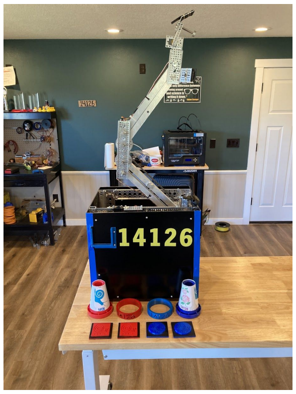
Upgraded encasement to polycarbonate



Design #1: scissor lift



DR4B v.1 prototype



Design #2: DR4B v.1

Design #3: DR4B v.2

The Journey of Our Arm

Design 1 - Scissor lift

- Problems: Too little torque, Too little speed

Design 2 - DR4B v.1

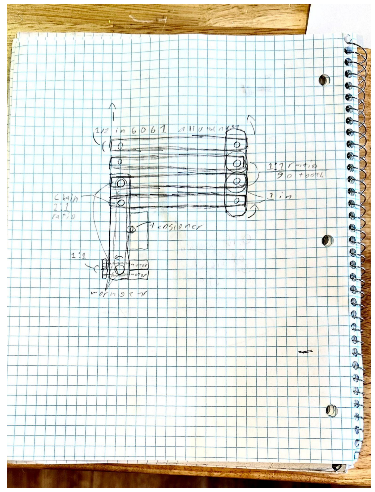
- Problems: extrudes too wide, head unit not centered, slop, lack of structural integrity

Design 3 - DR4B current version

- Solutions:
  - Narrowed extruders to center head unit
  - 3D printed and waterjetted custom parts to fully optimize design
  - Epoxied bearings to reduce slop

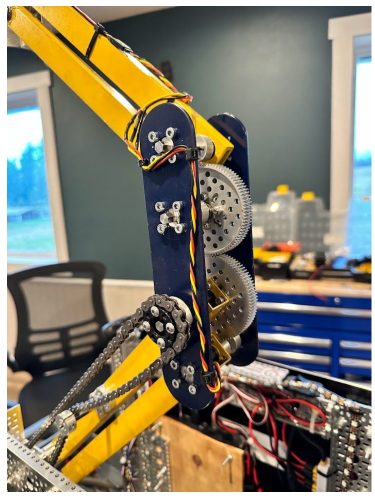
DR4B Arm

Our DR4B arm is fast, accurate, and pretty. **The arm is fully custom built** with waterjetted, chop saw and drill pressed parts. The arm utilizes a **DR4B linkage that turns the rotational motion of our chain drive into linear motion.** The chain drive lowers the center of gravity. The two four-bar linkages of the arm are connected by large gears, so when the first bar is swung by the chain, the second bar is swung the opposite direction, and both arms are lifted simultaneously. These grant us greatly increased RPM and Torque, with **more speed than our drive wheels!** The shape of our arm inspired us to name our robot “Luxo,” because of its similarity to the Pixar lamp named Luxo.

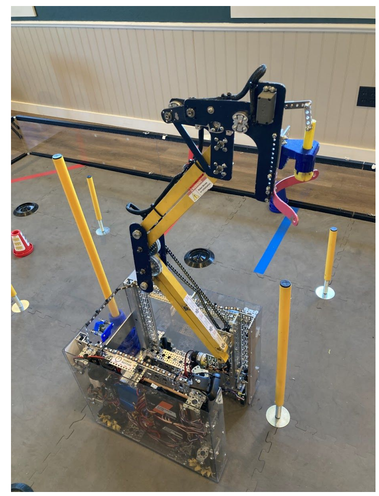


Sketch of the DR4B

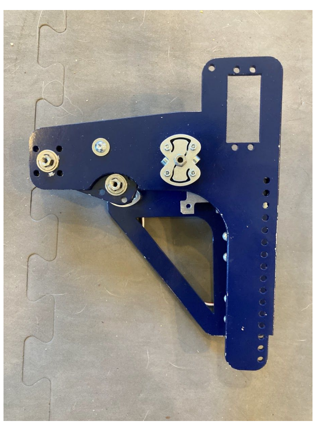
V.1 prototype



Current rear end assembly



Current DR4B



Retracted extension

Go Go gadget extension

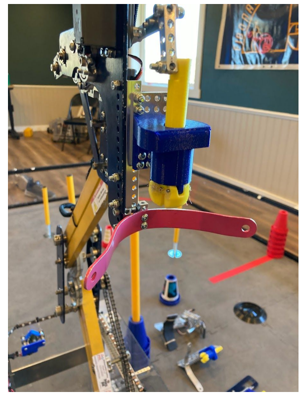
3D printed iterations of the extension

Horizontal Extension

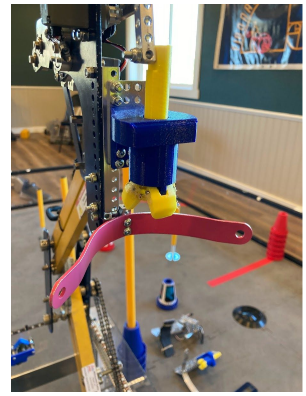
Our horizontal extension uses a 4-Bar linkage to **push our head unit 3 ¼ inches out of the frame of the robot.** We needed a reach so that we didn't have to straddle the junctions to deposit a cone. We kept it short in order to keep the **mechanism safe from collisions** with game elements and other robots. It is **completely made out of water jetted 6061 aluminum alloy**, and is the most aesthetically pleasing part of the robot. To prototype it, we 3D printed about 10 different iterations before making the version we have now.

Grabber

Our grabber is by far the most intricate part of our robot, with multiple tiny moving parts. It is **3D printed out of a mix of PETG and PLA filament.** It is designed to **plunge into the top of a cone and then expand inside** to hold it. It uses a servo to push a plunger down, which is attached to some teeth by a hinge. This shoves the teeth out and into the walls of a cone. We chose this design because we can line up to grab passively, which makes for **fast and accurate grabbing and releasing.**

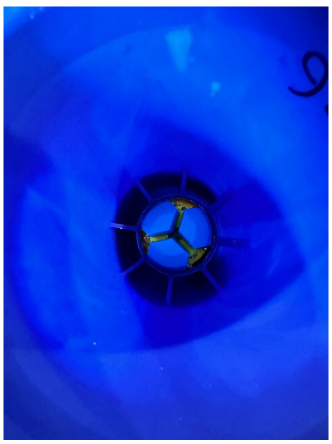


Grabber closed

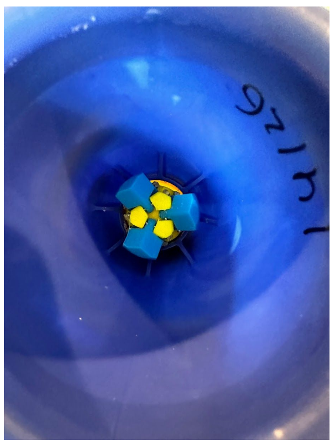


Grabber open

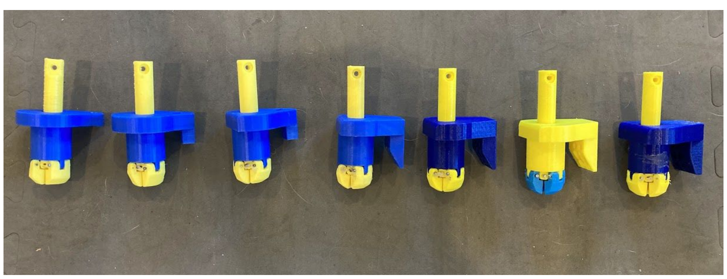
Inside of a Cone



Grabber closed



Grabber open



Iterations of our grabber
(left to right - oldest to newest)

Iterations of our head unit

The Journey of Our Grabber

Design 1 - Clamping Grabber

- Problems: inefficient, slow line up, inaccurate drops

Design 2 - Interior intake MK1

- Problems: mount was too weak, grabbed 2 cones at a time off of the stack

Design 3 - Interior intake mk2

- Problems: wide tooth profile, too big

Design 4 - Interior intake mk4

- Problems: PLA is too weak

Design 5 - Interior intake mk5

- Problems: PETG teeth are too brittle
- Solutions: switched material to PETG

Design 6 - Interior intake mk6

- Problems: TPU teeth are too grippy, teeth stretched and couldn't retract
- Solutions: Tested TPU, Teeth absorbed shock and held together

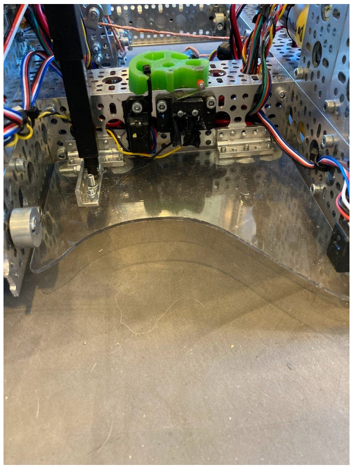
Design 7- Interior intake mk7 (current version)

- Solutions: Switched to PLA teeth, moved hole pattern to fit new head unit

Design/Innovate

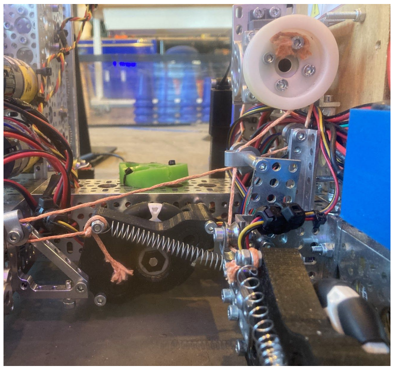
Plow

Our plow is a recent addition we added to **line up cones passively inside of the robot**. We use a linear servo to **raise and lower it**. We do this to keep the plow low enough to catch the bottom rim of the cone and raise it back up to prevent hitting the ground junctions and breaking it.

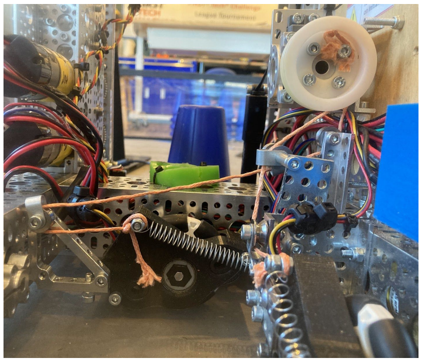


Plow raised to clear ground junctions

Plow lowered to line up a cone



Odometry pods raised to avoid damage during TeleOp



Odometry pods lowered for autonomous

Odometry Pod Lift

We encountered a problem with our **deadwheels getting caught against the ground junctions in teleOp,** so we created a system to pull the wheels off the ground. it utilizes a servo connected to **a series of pulleys to pull up the dead wheels in one smooth motion.** With the wheels completely removed from the ground, we can better travel the field without worrying about damage and obstructions.

Aesthetics

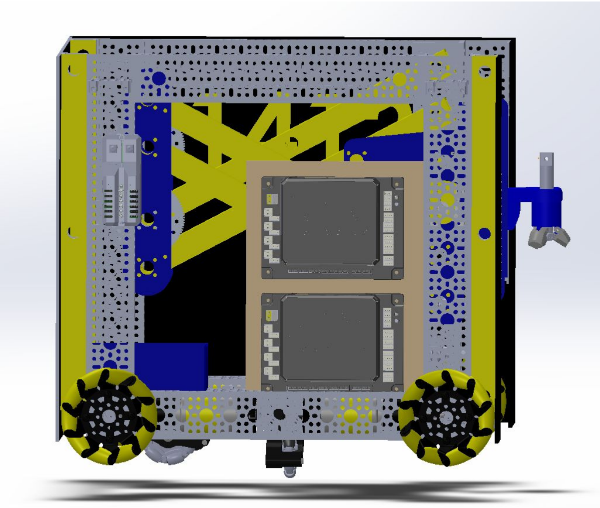
This year we experimented with making **vinyl wraps** for our robot to **make it fun and to protect from ESD.** We did this by making a design In publisher than printing It on strong sticker paper. Our wraps are removable so we can change them between tournaments. In addition, we **spray painted multiple parts of our robot** to make it easy on the eyes and also to protect the aluminum.

Abby cutting out a wrap

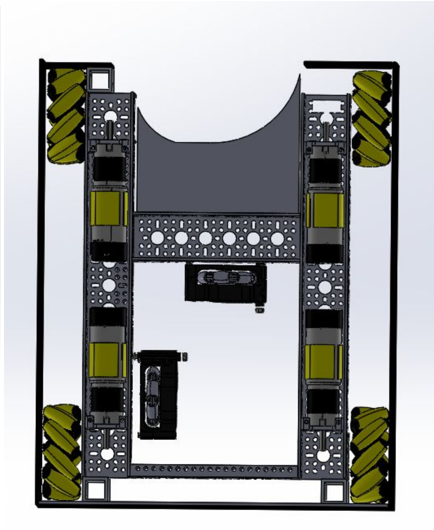
Wrap #3 on our robot

Goals:

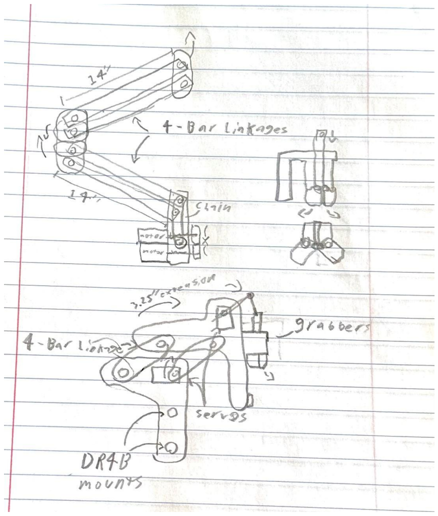
One of our engineering goals this year was to learn CAD not just to make custom parts, but to aid in designing mechanisms on the robot.



Control Panel CAD



Drive base CAD



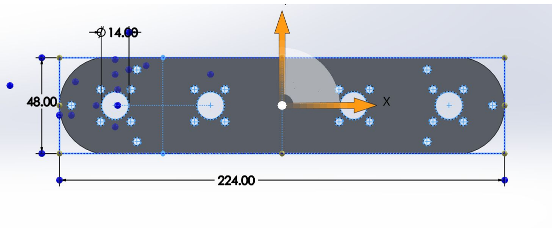
Sketches of arm/grabber designs

Learning solidworks:

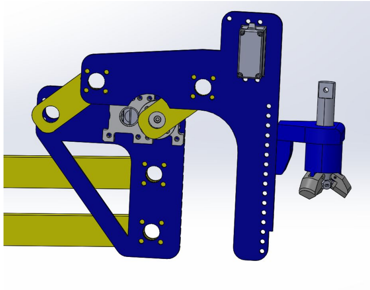
Besides a little experience in tinkerCAD and Inventor, **none of us had ever really used CAD**. we solved this by buying a udemy course and practicing over the off season. **We talked to mentors on both making designs in CAD and fabricating things with our CAD designs.**

Application:

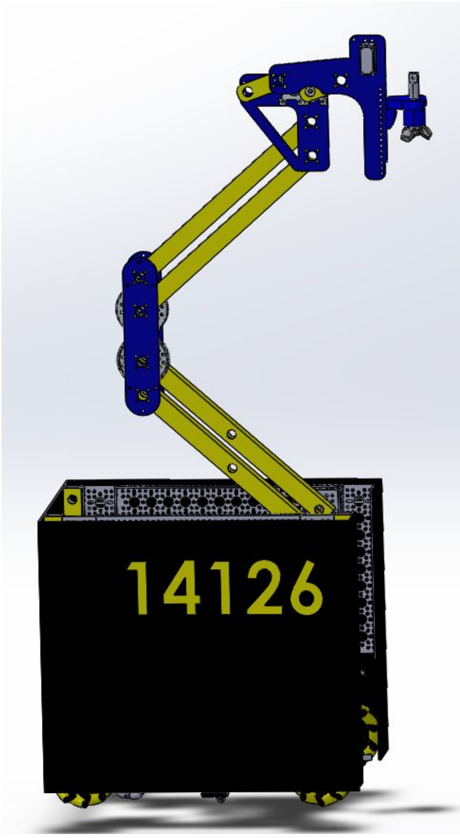
- Designing custom parts
- Designing complex mechanisms
- Visualising how components fit in the robot
- Testing mechanisms before building them



DR4B Rear end plate design



Reach CAD design



CAD Drawing of full robot

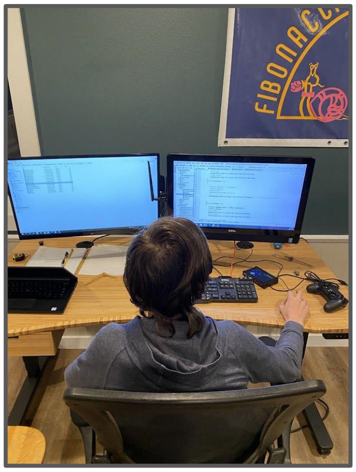
Code Team Plan

Leads: Solomon, Tasha
Support: Finn, Kennice

Individual Goals

Solomon		Kennice	
Goal	Accomplishment	Goal	Accomplishment
Improve our autonomous navigation	Implemented range sensors, odometry, and rewrote gyro	Try something outside of my comfort zone	Learned and implemented Vuforia and AI for detecting our signal sleeve

Tasha		Finn	
Goal	Accomplishment	Goal	Accomplishment
Improve drive controls in TeleOp	Created 9 presets for picking up and placing cones. Used TeleOp automation to pick up cones	Learn the basics of Java and coding in FTC	Used drive functions to program autonomous



Finn learning java

Code team working on autonomous

Mentors In Action

- **Sandra** - gyro, yoink mode, Vuforia troubleshooting
- **James** - logic, base code, troubleshooting
- **Aubrie** - control page
- **Alisha** - hypewoman, feeding the emo coders

Big Problems → Big Solutions

Code Team encountered many problems during the season. From connection issues to our robot's inertia, **we had to think outside of the box and research A LOT** to come up with solutions. Here are some problems we encountered and the solutions we came up with!

Problem	Solution
Inconsistent driving	Position based odometry, range sensors
Battery sensitive driving	Used velocity for drive speed
Over extending arm	Added extension limits using amperage
Cone pick-up takes too long	Created TeleOp Automation (Yoink Mode)

Control

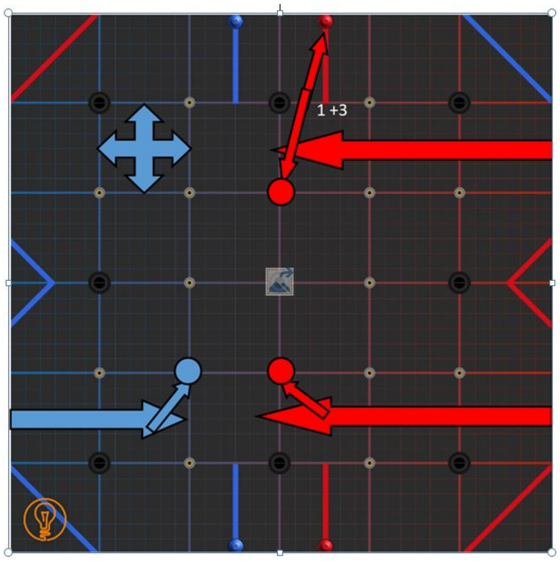
Autonomous Objectives:

- Deliver 5 cones onto a high junction in a 1 + 4 fashion
- Park using our custom sleeve

Sensors Used:

- 2 odometry encoders
- 4 drive motor encoders
- 1 range sensor
- gyro on the IMU
- 2 distance sensors
- 1 IR color sensor
- vuforia on the camera
- 1 limit switch

Autonomous Map



We programmed 4 different autos for the purposes of strategy and in case of mechanical failure

Driver Control Enhancements

- **Yoink mode** uses *TeleOp automation* to accurately pick up a cone with the single press of a button. Yoink mode uses 2 distance sensors and 1 IR color sensor
- **Arm reset** uses 1 distance sensor and a limit switch to reset the arm encoder values during TeleOp
- **Moving a plow** up and down automatically to square cones and prevent damage.
- **9 Preset buttons** programmed to go to a specific height using encoder values. 4 for delivering onto junctions and 5 for picking up from the stack.

Pole Detection

We are using a range sensor on the back of our robot to **detect the poles on the field and drive based on the values returned.** This allows us to **accurately drop cones in autonomous regardless of field discrepancies.**

Key Algorithms:

Our autonomous program uses 5 *drive functions*. The functions allow us to individualize inputs such as speed, distance, yaw angle, etc. The function will store the user input data into variables and use it within the function to be executed. All of our drive functions have **an input that will employ logic depending on which side of the field we are running on.**
Functions:

- GyroDriveENC: to drive forward and backwards accurately according to set path
- GyroDriveStack: to move forward until distance sensor sense the cones
- GyroStrafeENC: to move side to side accurately
- GyroSpin: to spin accurately according to set direction
- liftENC: to move the arm up and down safely

Driver Control Diagram

(Left = arm controls, right = drive controls)

Detection/Machine learning

For our detection this year we decided to try a ***machine learning tool.*** To use it we take a video of our *custom sleeve* and import it into the **FIRST machine learning website.** We go frame by frame telling the robot what each of our vision targets look like and giving them a name. Once it finishes we **import the file into our code telling the code** what to call the targets and we are done! Now the camera can correctly identify each of our targets.