FTC POWERPLAY
PORTFOLIO

ENIGMA 16265

2022 - 2023 SEASON

Team Summary

ENIGMA is a community-driven, practical learning experience led by volunteer coaches, mentors, and parents for students interested in STEAM and robotics in general. Our team is made up of public schooled and homeschooled students from the Albuquerque and Rio Rancho areas of **New Mexico**. We currently have 4 students. One of our students has experience with FLL, three in a new rookie FRC we started and one new comer. We currently have 2 coaches and **7 mentors**. Our team strives to be a family and **steward of the resources** entrusted to us helping grow students in their interests and abilities in STEM, skills in **problem-solving & team work**, business & presentation. We are eager to make a difference in students lives and grow FIRST in New Mexico! We accomplish these goals by focusing on **Individual & Team Building, Robotics, Engineering Connections and Community Engagement.**

Mission Statement

It is our desire to help students thrive in a world of technology and business, and ultimately create mentors that will carry on the torch to the next generation of students. -ENIGMA 16265

- Promote Community
- Lead
- Learn
- Have Fun
- Build Robots
- Help Others
- Teamwork

TEAM HISTORY | 2019-2023

WHAT WE'VE ACCOMPLISHED

(3x) Winning Alliance Captains of NM State 2020, 2021, 2022

2022 NM State Inspire award winner delivering us to **FTC World Championship**, 42nd in the World

- 41st in Franklin Division at 2021-
- Winning Alliance of AZ State Saguaro Division
- Invited to Maryland Tech Invitational at Johns Hopkins University
- 18 total awards
- Fundraised over $34k

Over 500 hours of outreach
Over 1,300 Instagram followers

How We Achieve Our Goals

We set very high goals and standards for our team. We believe that if we form a strong foundation, we will grow exponentially in all areas in the seasons to come. A huge part of this is defining how we will complete our goals. With the following three focuses, we believe we can build a very strong, competitive, and impactful team.

COMMUNITY ENGAGEMENT

ACTIONS

- Host/Attend STEM Events
- Collaborate with other teams, engineers, schools & lawmakers
- Start & mentor new teams
- Volunteer in the community

MISSION

To spread the impact mission, and life changing effects of FIRST throughout New Mexico and beyond.

INDIVIDUAL & TEAM BUILDING

MISSION

To form a strong, sustainable team and to grow individuals going into the world of technology.

ACTIONS

- Team Bonding Activities
- Efficient & Inclusive Structure
- Coach > Mentors > Student Leads > Other Positions
- Business & Sustainability Plan

ROBOTICS ENGINEERING

MISSION

To build a competitive robot, inspire others, learn real world engineering and problem solving skills.

ACTIONS

- Follow effective design process
- Utilize Math & Science
- Utilize CAD & Mechanical Sketches
- Consult real-life engineers
- Be willing to learn new things

INDIVIDUAL & TEAM BUILDING | MEET THE TEAM

Each season, our members choose what leadership positions and teams they are interested in. We then all work together to accomplish our goals!

That makes Vroomba only about 13 weeks old.

We're a smaller team this year, but that's because we split off and formed a new rookie team (ENIGMA TOO 22743) that we mentored for the first 12 weeks of the season. All to grow the New Mexico Region.

STUDENTS

NAME: Felix Martinez
AGE: 17 **EXP:**3

Team Role: Co-Captain, Build Lead, Pit Crew, Driver Two, Programming Team

Recruited through: Word of Mouth

Experience in: FRC and FTC

NAME: Callahan Williams
AGE: 12 **EXP:**0

Team Role: Managerial Team, Scout Team, Media Lead, Human Player

Recruited through: Manzano Teen Tech Center Open House

Experience in: FTC

Experience in: FRC, FTC, and FLL

Recruited through: Outreach event at the Natural Science and History Museum,

Team Role: Co-Captain, Build Team (CAD), Managerial Team, Fundraising & Outreach Team, Pit Crew, Driver One

NM Dean's List Finalist

NAME: Gray Sherwood
AGE: 17 **EXP:**3

Experience in: FRC and FTC

Recruited through: Enigma FTC Youtube Channel

Team Role: Scout Team, Build Team, Game Manual Specialist, Managerial Team, Drive Team Coach

NAME: Luke Conway
AGE: 14 **EXP:**1

COACHES

This season, We have been fortunate enough to have two wonderful coaches to help us through the FTC process.

Russ McCabe who has been a coach for Enigma 16265 for 4 years and is currently operating 2 tech companies. He's helped us with things from mechanical to electrical, always helping us to streamline our systems.

Dan Conway is a first year coach and is currently a real estate appraiser, who worked in the telecommunications industry for 23 years, and has extensive knowledge about the Android operating system.. His knowledge of useful gadgets and general know how was essential in building an effective workspace.

INDIVIDUAL & TEAM BUILDING

BUSINESS & SUSTAINABILITY PLAN HIGHLIGHTS

SWOT ANALYSIS

STRENGTHS

- Community-based (frequent meetings)
- Intense student commitment
- Business Plan
- Team works well together
- Very organized
- Many tools and expensive machinery
- Not opposed to change
- Experienced members

WEAKNESSES

- Lack of engineering connections
- Lack of students
- Lack of programming experience
- New Mexico is a small region
- Fewer matches then league play regions

OPPORTUNITES

- Skill & individual growth
- Grow FIRST in NM
- Collaborate more with other teams
- Secure more sponsors
- Volunteer more in the community
- Connect with the engineering community
- Win state competition & place at worlds

THREATS

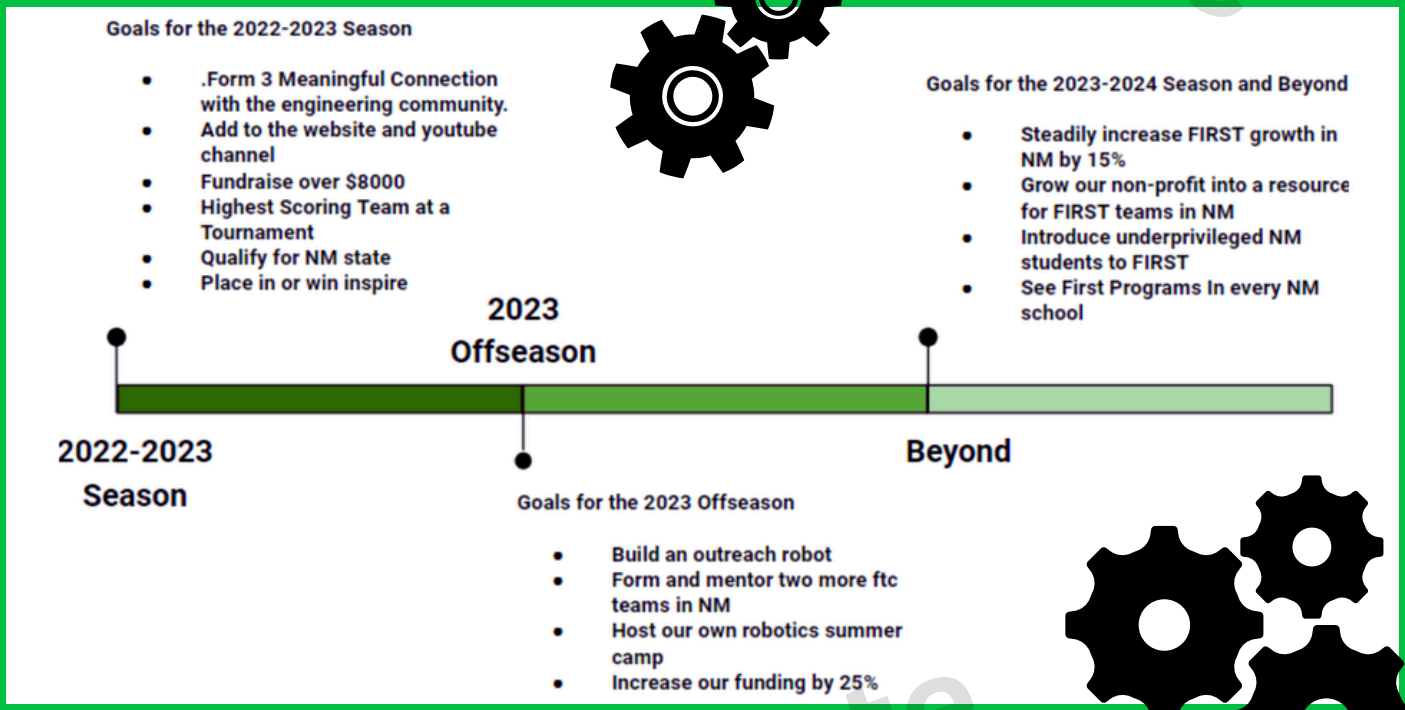
- Loss of students
- Loss of mentors
- Loss of funding
- Experienced students aging out
- Complete loss of funding
- Injury

WEAKNESS & THREAT IMPROVEMENTS: 2 EXAMPLES

Loss of Funding: Managerial Team - In order to decrease our risk of losing funding, we can apply for as many grants as possible. We can also try and gain sponsorships from a variety of companies. To avoid a complete loss of funding, our team needs income from multiple sources to be able to continue. Another way we can combat this issue is by being conservative in our spending and careful with our money.

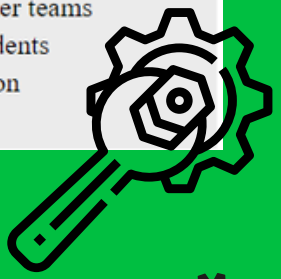
Experienced Students Aging Out: Managerial Team - Although we can not directly eliminate this threat, we can spread out leadership opportunities and train less experienced members throughout the off-season and league season, in order to ensure that when experienced students age out, the newer students can take over with ease. We will also thoroughly document our experiences and lessons learned throughout the seasons so they can be reviewed each season.

GOAL TIMELINES



GOAL ACTIONS: 3 Examples

THREE MEANINGFUL ENGINEERING CONNECTIONS	OUTREACH & FUNDRAISING TEAM	• Research local engineering companies and events for possible opportunities • Brainstorm what a meaningful interaction/relationship would look like
ADD TO THE WEBSITE AND YOUTUBE CHANNEL	TEAM LOOK/MEDIA TEAM	• Brainstorm ideas for possible content to add to website and youtube channel ○ Team blog, share team documents, tutorials, robot reveals, bloopers • Act on ideas and assign tasks -writing, taking pictures, filming, editing
FUNDRAISE OVER $8,000	OUTREACH & FUNDRAISING TEAM	• Research successful fundraising strategies from other teams • Form a comprehensive plan and assign tasks to students • Follow through throughout the off-season and season • Seek for new connections and fundraising ideas



COMMUNITY ENGAGEMENT | OUTREACH

New Mexico is a small FIRST region, so ENIGMA strives to grow the FIRST community here. We accomplish this by reaching out to our community, and hosting and participating in outreach events to spread awareness of STEM and FIRST in our community. ENIGMA taught the FLL classes through other organizations.

We did not set the COVID-19 safety measures.





14 FLL CLASSES

We have taught two seven-week FLL classes this season at Abundant Homes and Parent Led Academic Network Team. Students for the first seven week class were split up into teams of three and were given 1-2 FLL missions to complete. For the second seven week class kids were split into teams of 2 teams of 8 kids each and they were given 5 FLL missions to complete. We used the field and challenges from the 2022-2023 FLL challenge, Superpowered. We taught the kids age-appropriate engineering concepts, FLL core values, and blocks programming. They brainstormed, built, and programmed their robots from scratch. At the end of the classes, each team ran their robots and completed their missions.

MANZANO TEEN TECH CENTER

This year, we have been given an amazing opportunity to work with multiple FIRST teams at the Manzano High School Teen Tech Center. We were invited to the Teen Tech Center by Chris Forscyte, a coach for the FRC team 8512 the Manzano Monarchs. We are also sharing the space with FRC team 7540 Timberwolf Robotics, FRC 9080 Enigma, and our sister team, FTC 22743 Enigma Too.

MANZANO TEEN TECH CENTER OPEN HOUSE

In November, we hosted an open house at the Manzano Teen Tech Center, along with the other teams working there. The open house was largely effective in gathering interest in the FIRST community. We were able to recruit 11 members into the FIRST program.

COMMUNITY ENGAGEMENT | EXPANDING FIRST LOCALLY

FORMING FIRST TEAMS IN OUR AREA

We have formed two **FIRST teams** in our local community. Our sister FTC team, **22743 ENIGMA Too** and a new **Rookie FRC Team ENIGMA 9080 with 3 of our members participating**. We only had 6 weeks to build our robot because we were helping ENIGMA Too build their robot. ENIGMA Too won the design reward in the Alamogordo qualifier. At the Albuquerque qualifier we got runner up while partnering with Enigma Too. Our FRC team is currently working hard for their competitions in March. They have assembled a chassis and are looking to be a competitive team.

MENTORING LOCAL ROOKIE TEAMS

This season we were also able to mentor several local rookie FTC teams **#21797 Hack City** and **#21749 Out of the Bot Robotics** that is located here locally. We were happy to give them some of our advice and knowledge that we have gained from experience with various subjects, but primarily programming, and electrical stuff.

MENTORING REMOTE TEAMS ON INSTAGRAM

With over 1338 followers on Instagram we are able to often connect with and mentor remote teams. We have answered tons of questions, shared our engineering portfolio, Shared our GitHub repo of code for this years and previous years robots.

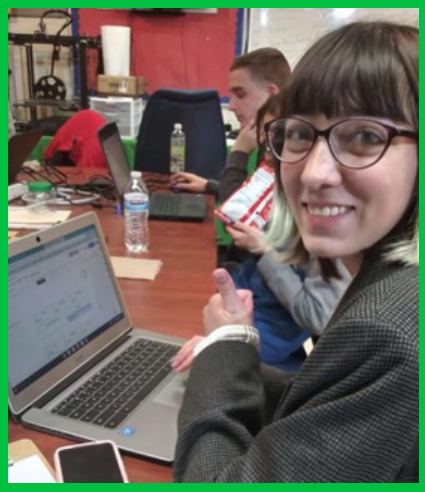
@enigma.robotics

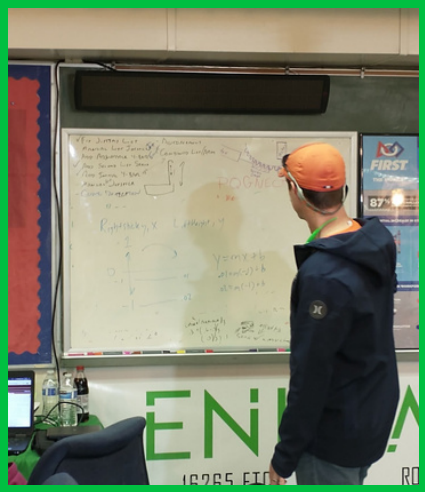
SHARING RESOURCES WITHIN OUR FIRST FTC FAMILY

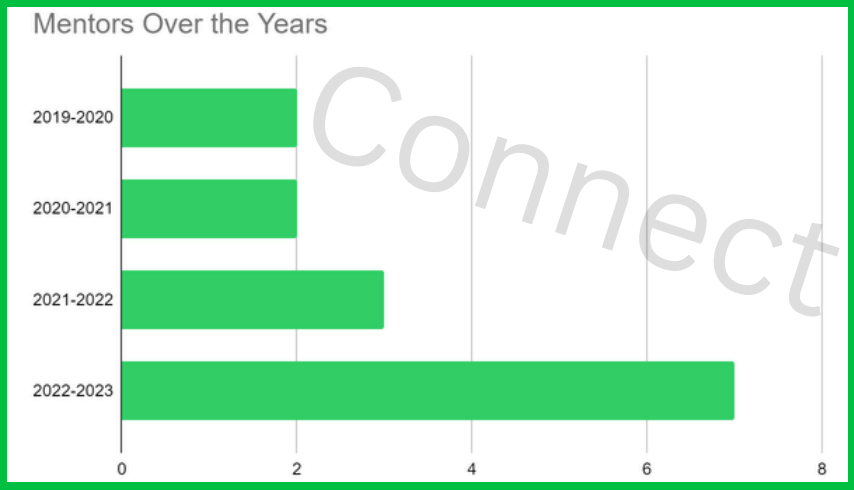
We think it's very important to share resources and to be as helpful as we can. This season, we have shared our team's engineering portfolio with other teams, helped teams who have trouble with their bot at competitions, and have shared our tools and knowledge at competitions past and future. For example, we demoed our robot for another local rookie team #21797 Hack City, as well as giving them brand new electronics for their robot to start, and helped them with programming. We also formed a sister team #22743 Enigma Too, to continue the growth of FIRST in our region and as a whole.

MENTORS | ENGINEERING CONNECTIONS

Most of our **mentors are engineers** and help us by using their experience in STEM fields to show us new ways to solve our problems with the robots. We have also tripled the number of mentors we have from last year to now.







This season, We have been fortunate enough to have a large and diverse mentor group of **7 Mentors** to help us through the process, over doubling our mentors from last season

Renzo Del Frate - Research Engineer at Sandia National Labs, 4th year mentor

Jason Velasquez- Mechanical Engineer at Sandia National Labs, 1st year mentor

Dave Copithorne - Software Engineer at Sandia National Labs, 1st year mentor

Denise Lanza - Program Manager at Leidos, 1st year mentor

Matt Williams - Mechanical Engineer at Sandia Labs, 1st year mentor

Isabel McCabe - ENIGMA 16265 Founder and FIRST Alumni, and student at **Johns Hopkins University**, 1st year mentor

Madelene Ciccarelli - ENIGMA 16265 Founder and FIRST Alumni, and student at the University of New Mexico, 1st year mentor

ROBOTICS ENGINEERING | DESIGN STRATEGY & PROCESS

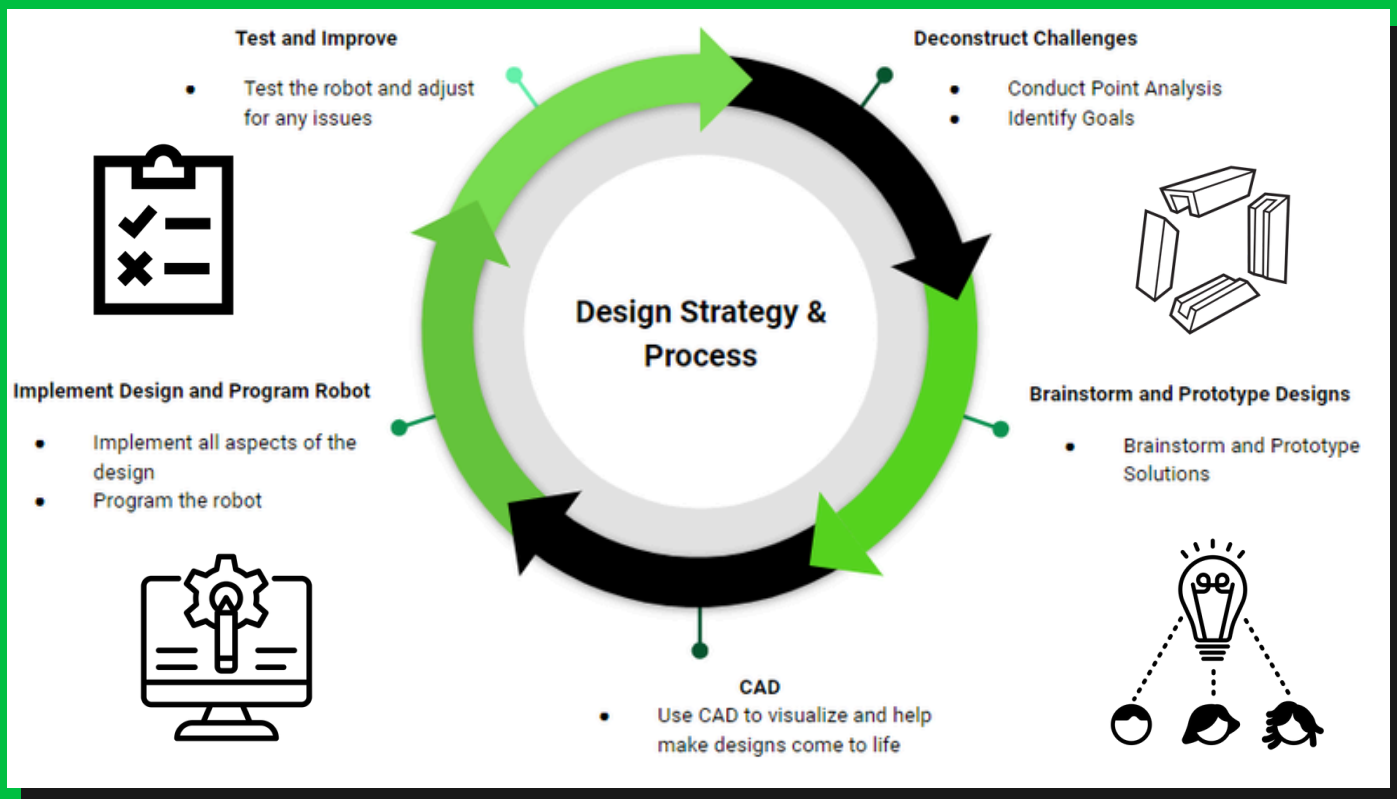
Simple Rigid Linear Occam's Razor

No Unnecessary Motion Measured in Seconds

When designing, we are always thinking about the fastest possible way to get the game piece from its 'default location' to its 'scored location'. There is **no unnecessary motion**, and the mechanisms that complete each task are **fine-tuned**, **simple**, **rigid**, and **linear**. Each mechanism, whether isolated or parts of a whole, should be linear and **quick**, similar to **Occam's Razor**. Each mechanism's ability to complete its task is **measured in seconds**. Mechanisms are improved as much as possible to achieve the fastest system of moving parts.

From a competition standpoint, **we are only competing against ourselves and the clock**. In each round, we have 2 minutes and 30 seconds to gain the most points possible. It is always our goal that our robot completes all autonomous point opportunities and, in tele-op, score points as efficiently as possible.

DESIGN PROCESS - CONTINUOUS PROCESS IMPROVEMENT

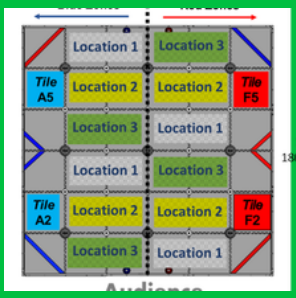


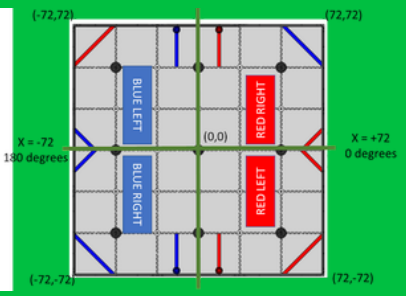
STRATEGY & PROCESS- (1) Conduct Point Analysis

For the first portion of our design process, we looked at all the ways to score on a computer screen. We went through each one, clarifying the task and reading the rules.

Autonomous	Pts
Cone in Terminal	1
Cone on Ground Junction	2
Cone on Low Junction	3
Cone on Medium Junction	4
Cone on High Junction	5
Parking with Custom Signal Sleeve	20

Tele-Op	Pts
Cone in Terminal	1
Cone on Ground Junction	2
Cone on Low Junction	3
Cone on Medium Junction	4
Cone on High Junction	5





End Game	Pts
Junction Owned By Beacon	10
Junction Owned by Top Cone	3
Parked in Terminal	2
Circuit	20

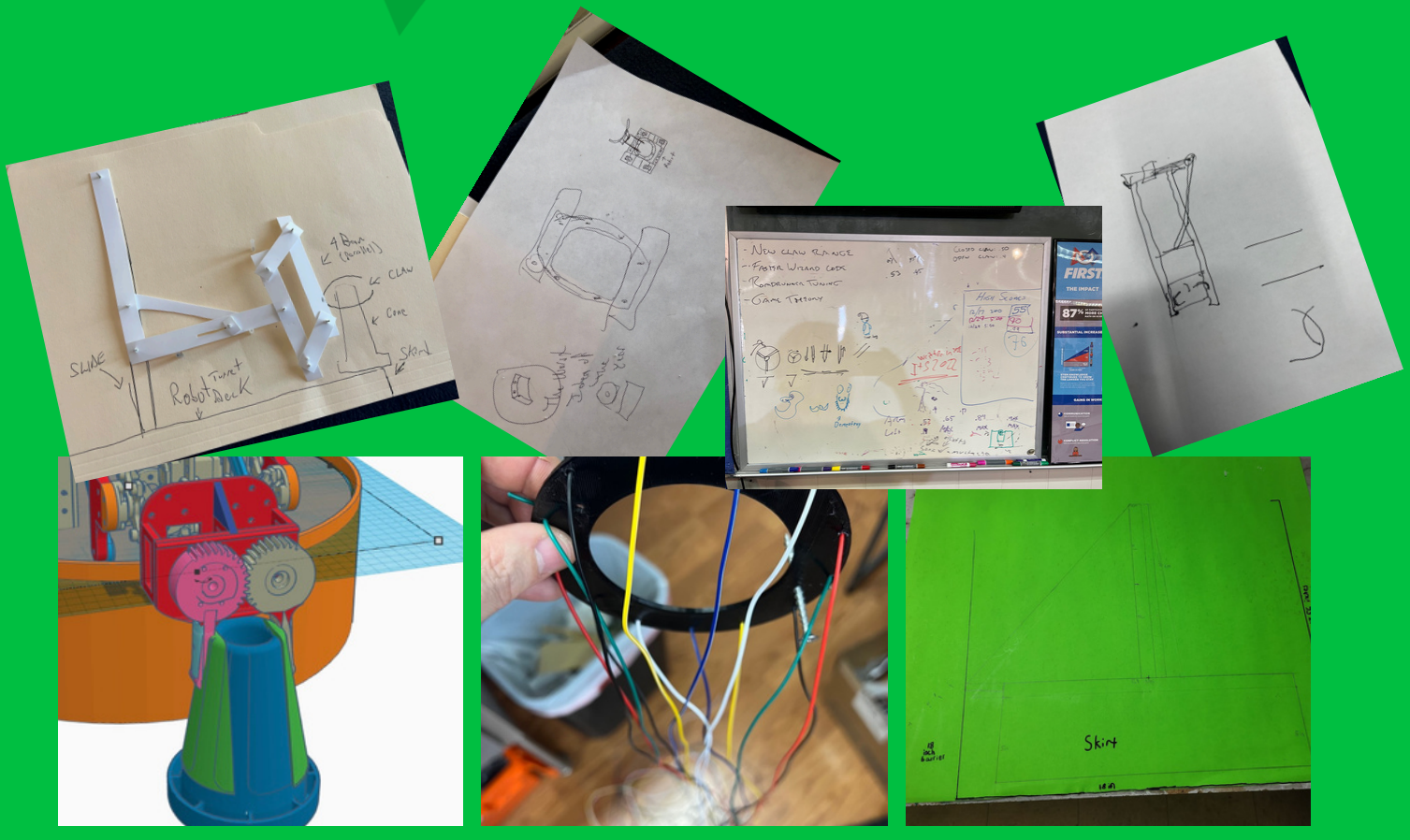
STRATEGY & PROCESS - (2) Identify Goals

Then after analysis, we proceeded to set some goals for our robot to compete efficiently.

STRATEGY & PROCESS Cont'd - (2) Identify Goals

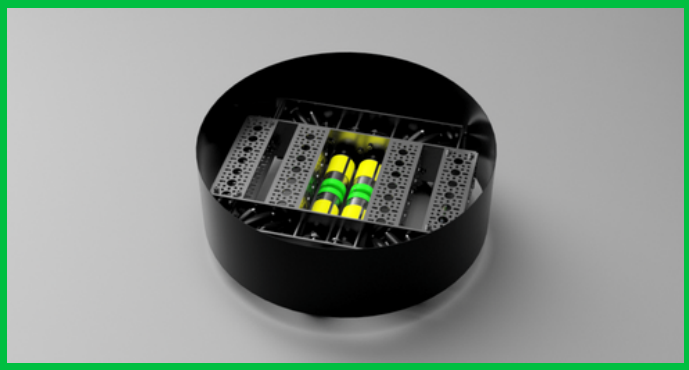
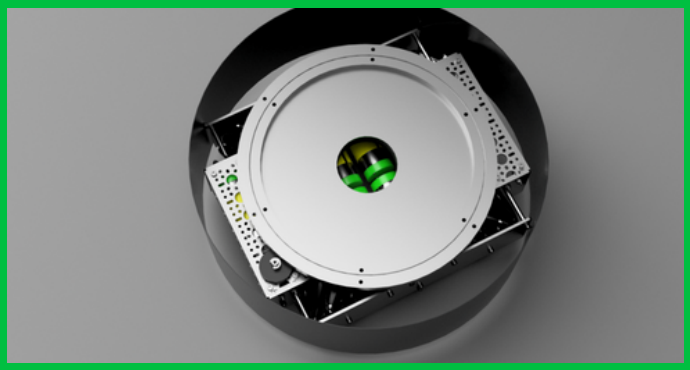
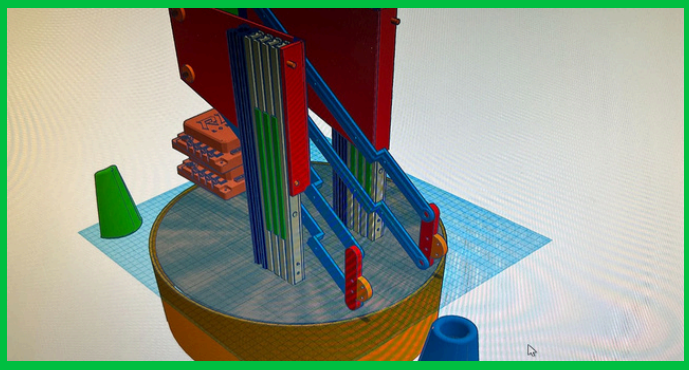
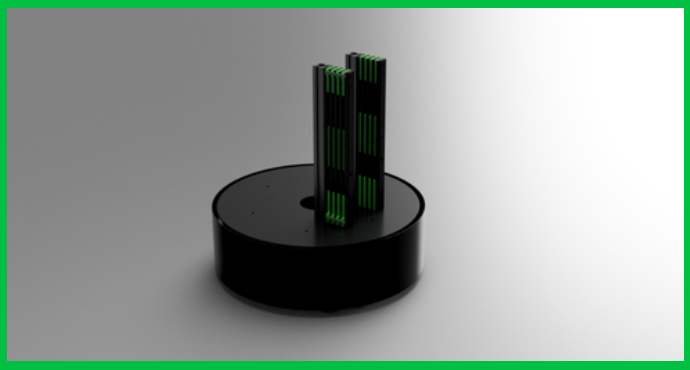
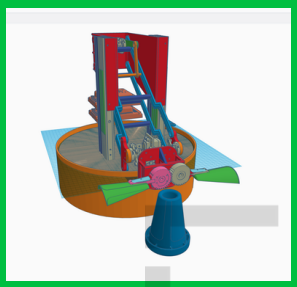
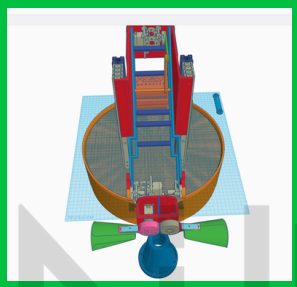
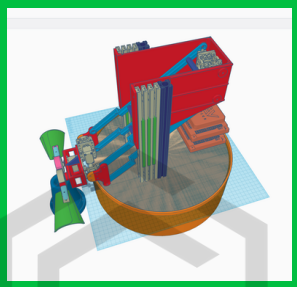
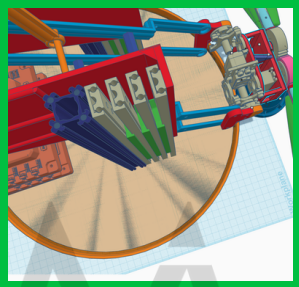
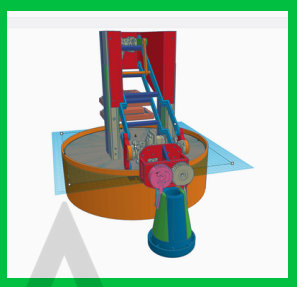
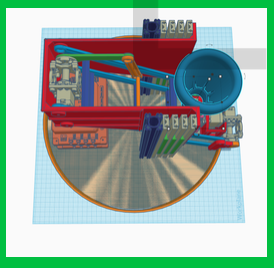
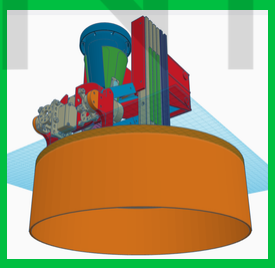
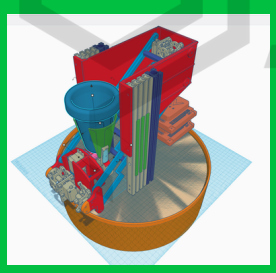
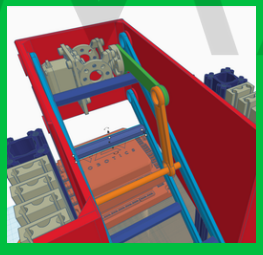
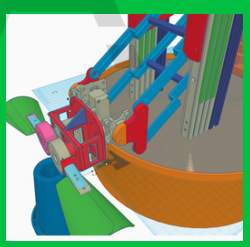
GOALS	Plan to Achieve Goals
Strong Reliable Autonomous	Effective Strategy and Programming
Quick and Efficient	Sleek design, and Easy Maneuverability
Ability to Easily Navigate the Field	Light Design, Good Driving
Adaptable To Multiple Strategies	Build a Versatile Robot Capable of Placing on all Junctions

STRATEGY & PROCESS - (3) Brainstorm and Prototype Solutions



STRATEGY & PROCESS - (4) CAD

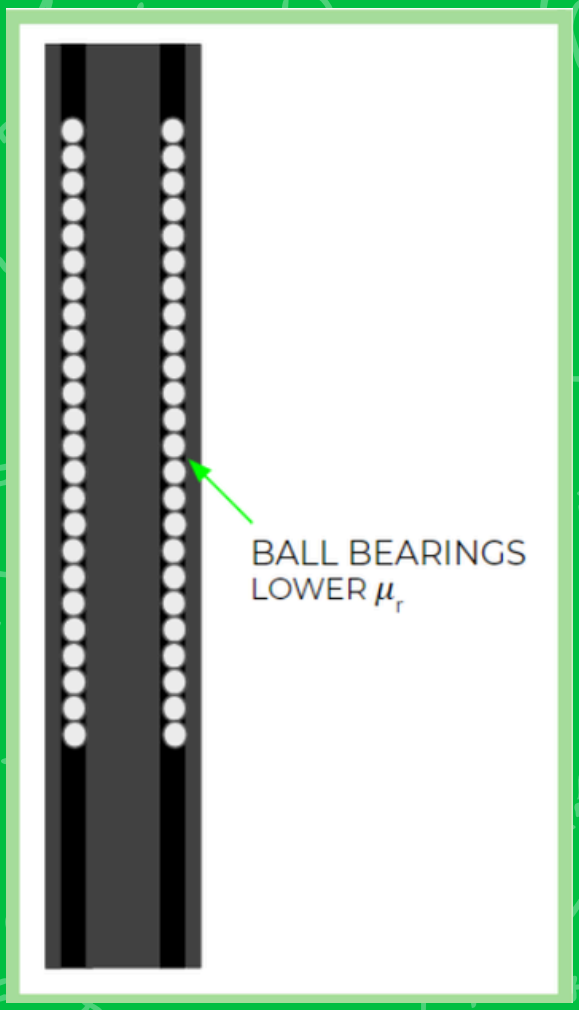
We chose to CAD our robot using **Fusion 360** this season, because of its easy to use yet equally complex system. Fusion 360 is also a great program due to its versatility. CAD is an important part of the engineering process and is extremely applicable to the real world workplace. **CAD software** helps us to detect any spacing issues or flaws with our design. CAD is also useful for 3D printing parts and milling parts. 3D printed and milled parts are extremely helpful and common in our robot. We also used **TinkerCAD** as it's very simple.

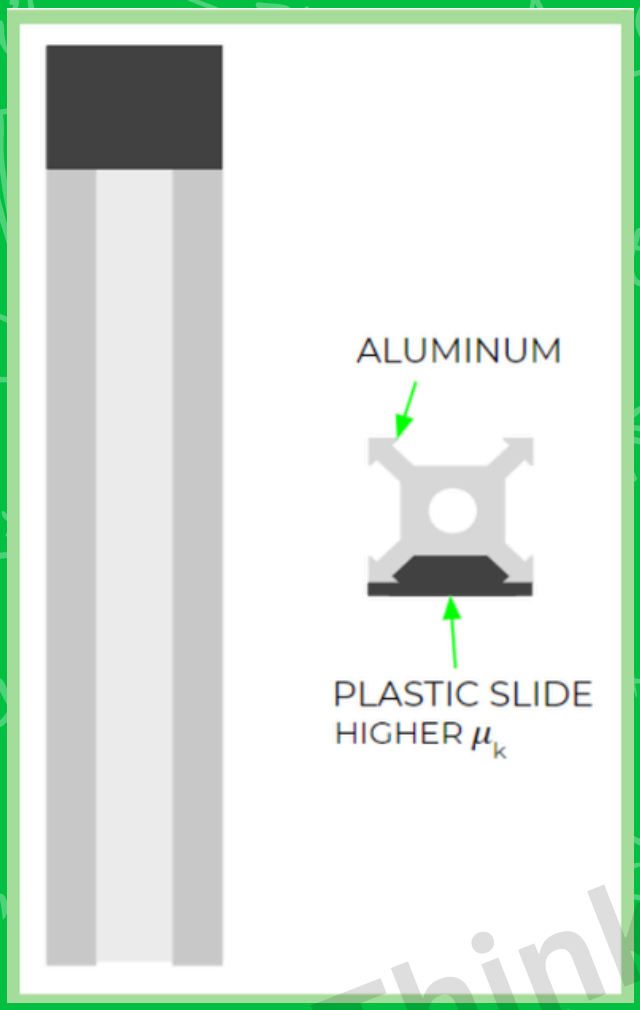















STRATEGY & PROCESS - (5) DESIGN

MATH AND SCIENCE BEHIND OUR DESIGN | SLIDES EXAMPLE

Ball Bearings Drawer Slides vs. Aluminum on Plastic Extrusion
A large goal when designing our robot is to maintain speed and consistency, thus, we utilize ball bearing systems all over our robot. Nearly every joint that has rotary motion uses ball bearings. Ball bearings dramatically reduce friction in rotary motion.
The equation for kinetic friction, F_f, is the coefficient of kinetic friction, μ_k, is the coefficient of kinetic friction, F_n.





$$F_f = \mu F_n$$

Ball bearings reduce friction because they roll rather than slide, and when the balls are rolling, they almost always have a much lower coefficient of friction (on the order of 0.001 and referred to as rolling resistance with ball bearings; denoted by r) than if two flat surfaces were sliding against one another (on the order of 0.3).

STRATEGY & PROCESS - (6) Programming

SENSORS

We use a distance sensor to sense the distance between the cone and the claw. We used three **Dead Wheel Odometry** encoders for **localization** and **motion profiling**. Two magnetic limit switches to home the turret and to prevent the lifts from going too far down. All of which we go into more detail in the code section.

CODE

We use **Android Studio** because it gives us more flexibility and allows us to use the Road Runner opensource motion profiling library for odometry. We use 3 dead wheel odometry for autonomous making the robots movement more accurate allowing us to stack more cones. We use **right triangle trigonometry** and **PID control** to correct for drift. We use a camera with image recognition called **Open-CV** which senses the **April Tag** on the signal cone. We also use a distance sensor so when the cones are a certain distance from the sensor the robot automatically picks up the cones. In Tele-op we utilize magnetic limit switches to decrease the possibility of the robots mechanisms over-extending and breaking.

```
//Initialize any other TrajectorySequences as desired
TrajectorySequence trajectoryAuto, trajectoryParking ;
//Initialize any other Pose2d's as desired Pose2d initPose; // Starting Pose

//Set all position based on selected staring location and Build Autonomous Trajectory
public void buildAuto() {
    SampleMecanumDrive drive = new SampleMecanumDrive(hardwareMap);
    Pose2d startPose = new Pose2d( x: 0,  y: 0,  heading: 0);
    switch (startPosition) {
        case LEFT:
            trajectoryAuto = drive.trajectorySequenceBuilder(startPose)
```

```
void tagToTelemetry(AprilTagDetection detection)
{
    telemetry.addLine(String.format(Locale.ENGLISH, format: "\nD
    telemetry.addLine(String.format(Locale.ENGLISH, format: "Tra
    telemetry.addLine(String.format(Locale.ENGLISH, format: "Tra
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}
```
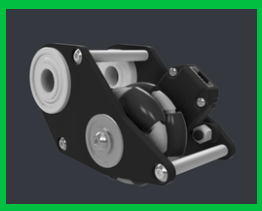
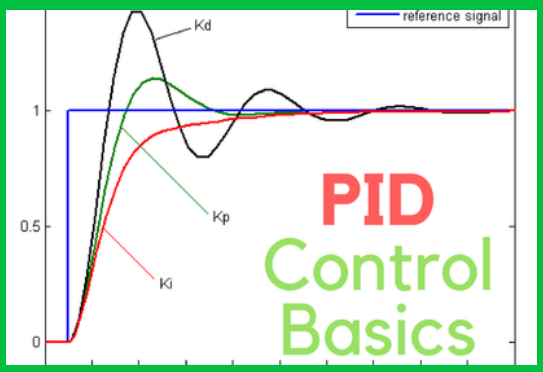
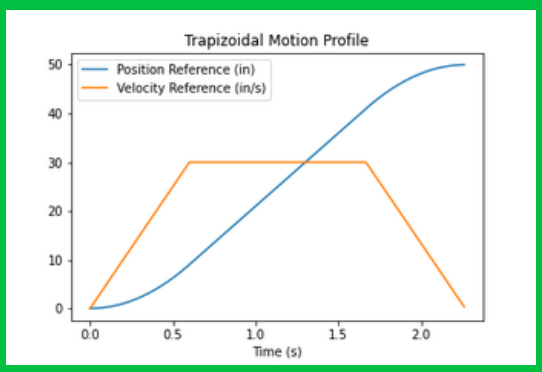



DEAD WHEEL ODOMETRY POD

OpenCV

android studio



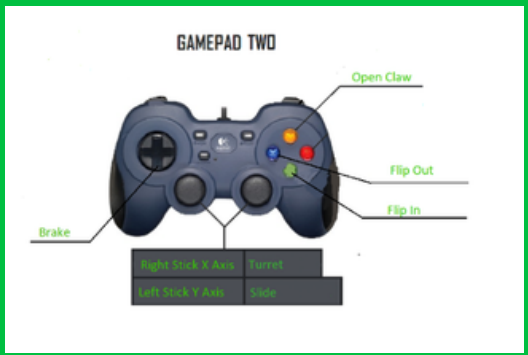


CREDIT TO CTRL ALT FTC AND TEAMS: 22377 AND 19376 FOR THIS GRAPH ON MOTION PROFILING

APRIL TAG

STRATEGY & PROCESS - (7) Test and Adjust

CONTROLS



Problem	Solution
Lift string tangling on retraction	Added retract pulleys and tensioners to deck plate and placed for correct geometry
Weight causing turret to turn chassis	Redesigned mechanism shedding almost 6 lbs. Total
Turret belt slipping on pulley	Added idler to tighten belt
Turret not spinning smoothly	Added support bearings to bevel gears
Slides not sturdy	Tightened the base and added steel washers to make them more sturdy
Turret overshooting	Added a break on a servo that is attached to the deck plate
Cone falling on deck plate and stuck in the robot for a penalty	We added a piece of cloth so that cones can't get stuck in between our lifts

WEIGHT REDUCTION

RETRACTION PULLEY TENSIONER

TURRET BRAKE