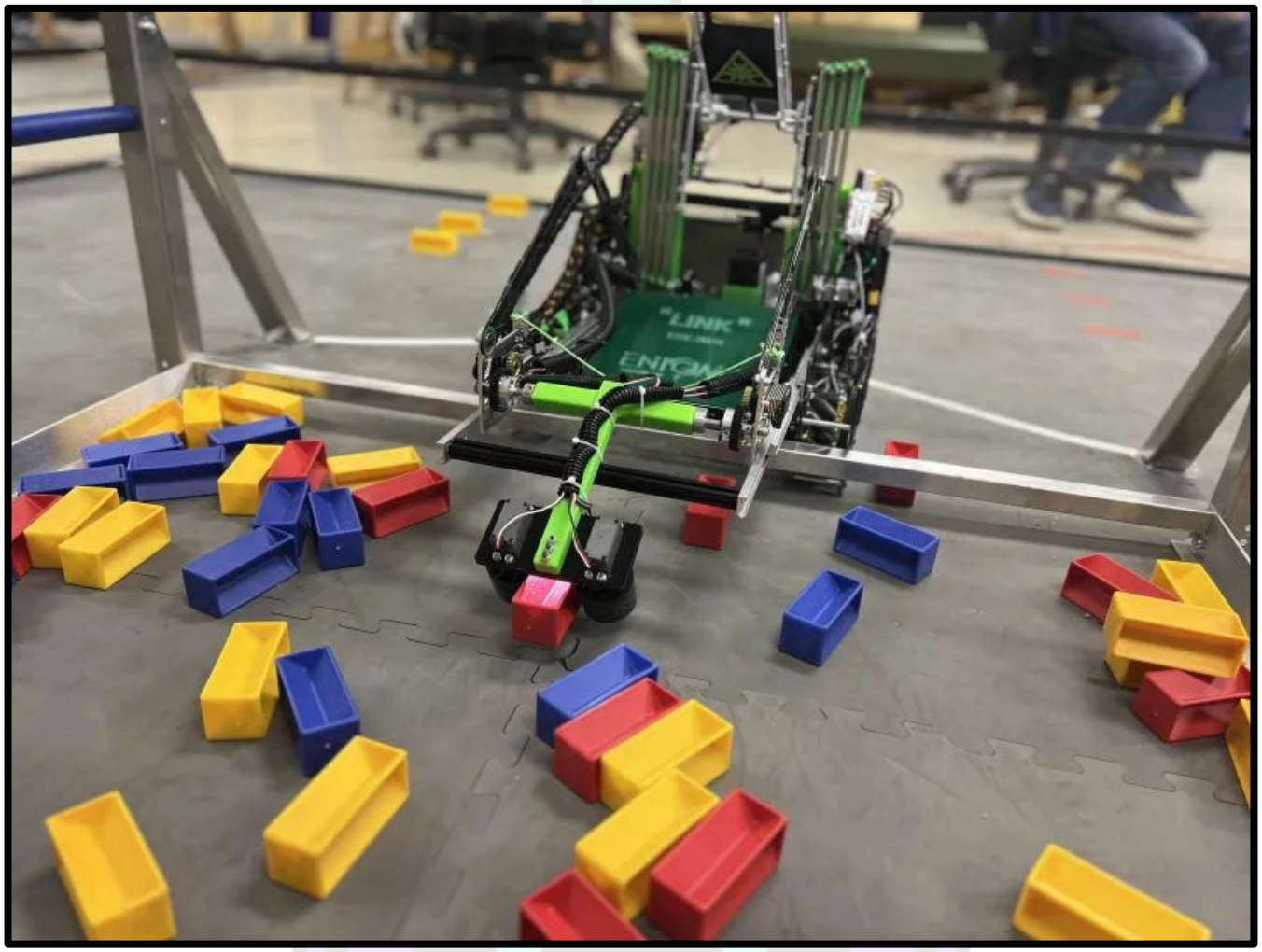
ENIGMA 16265
2024/2025 Portfolio

"Where Mysteries Drive Masteries"



2024-'25 Enigma FTC Robot - Link

2024-2025 ENIGMA Robotics Team Members:

Luke Age 16
4 Years Experience
Co Captain, Drive,
Design, Build Teams

Callie Age 14
3 Years Experience
Co Captain, Drive,
Business, Build Teams

Jett Age 15
3 Years Experience
Design, Programming
Teams

Elliot Age 13
3 Years Experience
Programming and
Drive Teams

Gabriel Age 13
2 Years Experience
Build Team

Anirudh Age 16
2 Years Experience
Design, Build, Drive Teams

Cody Age 16
2 Years Experience
Design, Marketing Teams

Sammy Age 15
2 Years Experience
Build and Programming
Teams

David Age 13
1st Year
Build Team

Phillip Age 16
1st Year
Design and Build Teams

Davy Age 15
1st Year
Build, Programming,
Business Teams

Lorelai Age 13
1st Year
Programming Team

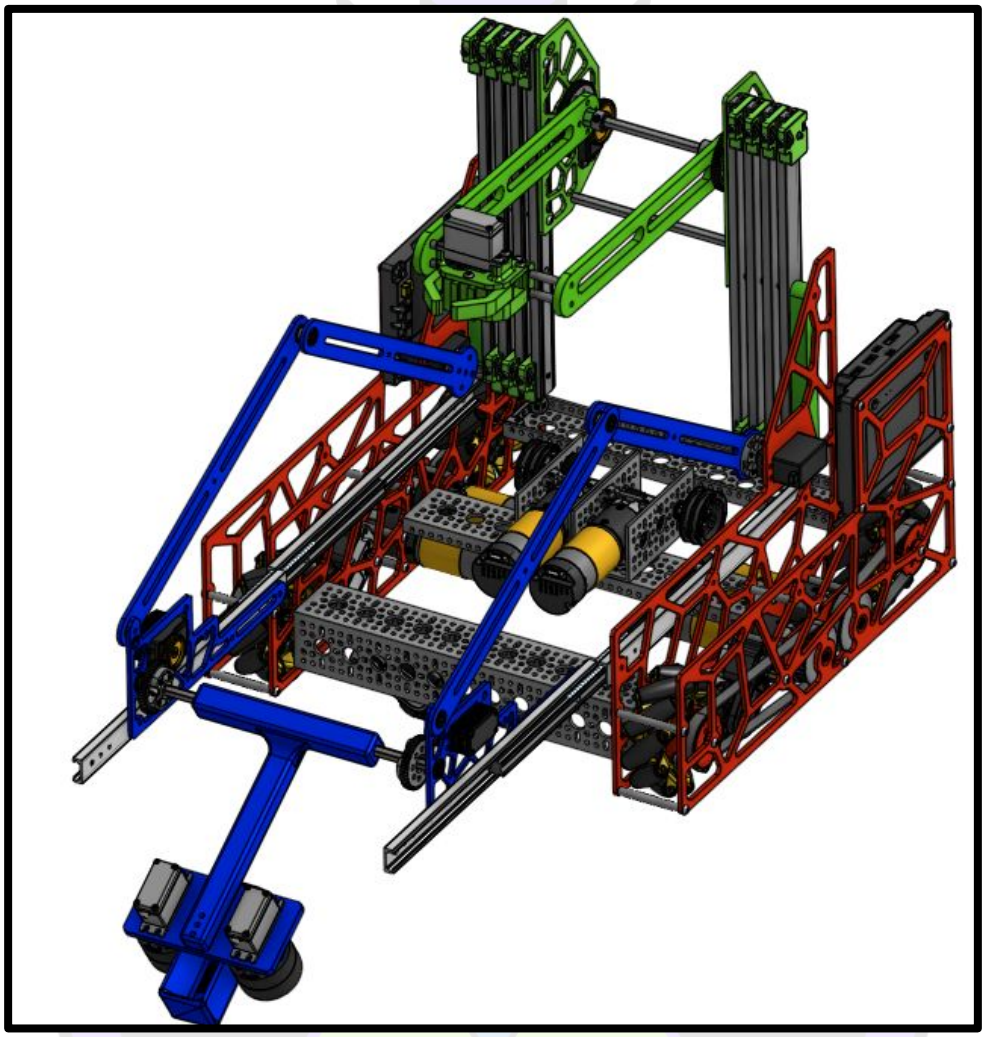
Coach Russ
6th Year
Technical Coach

Coach Dan
3rd Year
Managerial coach

Mechanisms/Subsystems

Design

Our Robot can be divided into 3 main subsystems, our intake, our outtake, and our drivetrain. These three systems were designed to be assembled individually and then brought together later. This allows for an easy way to make changes or fixes to the robot while still allowing for a complex robot.



We use a custom made parallel plate mecanum drivetrain. This allows for a robust drivetrain as well as customizable mounting options for our other subsystem.

Our intake utilizes servo powered compliance wheels to intake the specimens. This is placed on an extending slide system and an arm to allow for easy reach into the submersible

For our outtake we use a continuously strung slide system powered by two 1150 rpm motors. We utilize a claw to grab specimens from our intake, and to score specimens and samples.

Link The Robot

Design

How our robot works:

- Our intake picks up the sample, then it transfers to the outtake and the slides move up to the height needed to score, outtake dumps sample out into bucket
- We decided that the best strategy was to cycle samples into the buckets so we made being able to score samples a top priority

Elegance

- Our robot elegantly moves through all parts of the game from intake to outtake

Efficiency:

- With an extending active flywheel intake, our robot can shorten cycle times and reach over the submersible barrier
- Our pocketed parallel plate drive system makes the inside of our robot easily accessible, allowing for repairs to be much faster
- The robot is built to reach the higher bucket because we calculated that was the most efficient option
- We decided to go for a very modular design, allowing for mechanisms to be swapped and replaced with just a few screws.

Our Aesthetic

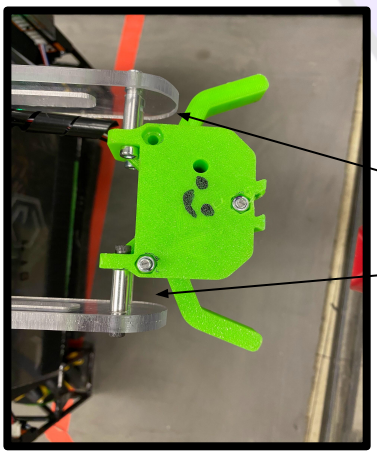
- To create a sleek look for our robot we achieve this through our bright green 3D printing and our black CNC parts
- We also used pocketting on all CNC parts to help with the look of our robot

Robot function:

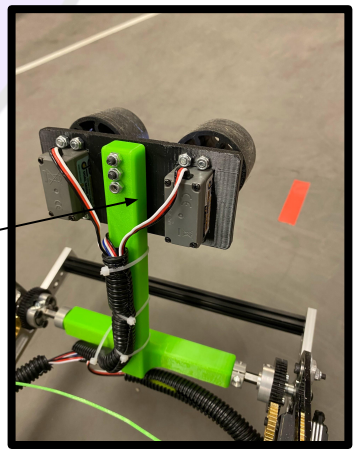
- Our robots intake function was based on the fact that there is walls lining the bottom of the submersible this caused us to create an extending intake to reach over the bars.

Our design:

- We began CADing our robot in the off season of 2024, starting with the parallel plate design

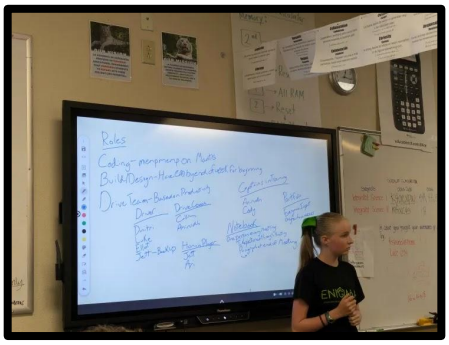


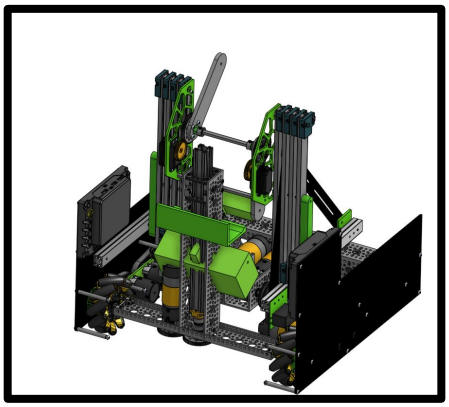
Easy places to swap out parts

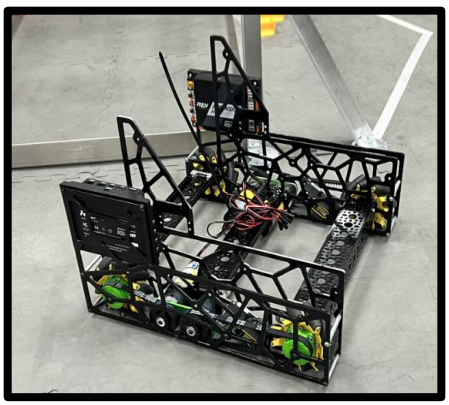


ENIGMA Robotics Design and Code Timeline

Design and Control







9/7/24:

- Game reveal - analyze game
- Vote as team on initial design decisions
- Decide team roles, and make plans for working on CAD

9/10/24:

- First Official Team Meeting
- Discuss new design ideas and continue making decisions
- Made a very rough TinkerCad sketch of robot

10/12/24:

- Initial CAD Finished
- Began manufacturing parts using 3D Printing and CNC machining
- Began ordering parts

10/22/24:

- Finished Ordering Parts

11/10/2024:

- Drivetrain structure
- Began mounting intake

11/12/24:

- Outtake Mounted

11/19/24:

- Started Wiring

11/30/24:

- Finished Wiring
- Finished Drive Code
- Mostly Finished Intake Code

12/1/24:

- Got all Basic Tele-Op Code Done

1/14/24

- Got 2 specimen autonomous

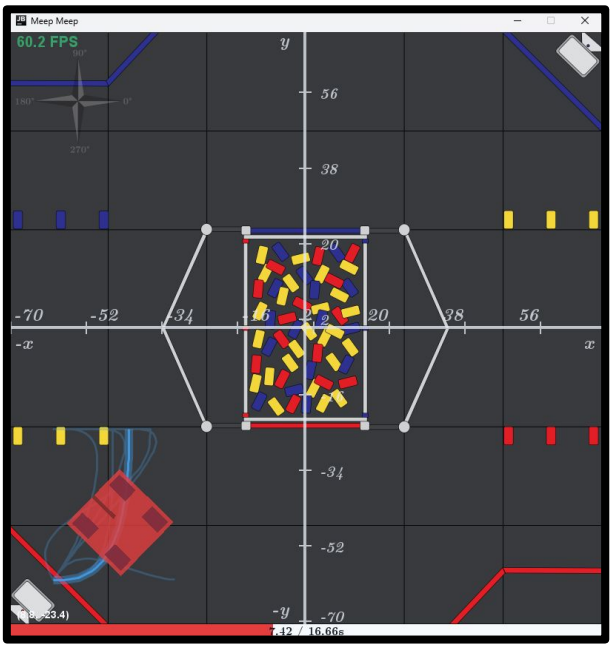
Control Award

How we control our robot:

- Used Gobilda odometry pods and roadrunner to correct inconsistencies in autonomous
- Active intake allows the robot to intake much faster
- Strings use tension for slides to keep slide movement compact

How can we improve our reliability:

- We could add a distance sensor to the claw, so that it automatically grab samples placed in front of it.
- Better picking up at an angle
- Transfer from intake to outtake



Meep Meep Autonomous Pathing with Roadrunner

	Servo/Motor	Odometry Pods
How it works	A servo rotates to a set position and stays there A motor rotates at a set power for a certain amount of time. They are more powerful than servos, but you can't set their position with as much accuracy.	Odometry Pods utilize a free spinning dead wheel sprung to the ground. It's rotation is measured by an encoder.
Purpose	Although servos are somewhat weak, they can be used in places where precision is required over Motors are used in systems that require more power like drivetrain or our lifts. power	We use the information gained from the odometry wheels to make accurate autonomous pathings, using roadrunner

Problem Scoping	Critical Solution
Our intake and outtake weren't working very well at the Alamogordo scrimmage	Replaced Intake and outtake with a more reliable system
We would sometimes intake the wrong color of sample	We added a color sensor and coded it to sense for if we had intaked the wrong color of sample
Autonomous was running out of time	Sped up actions to save time
Our auto wasn't working very well at the alamogordo scrimmage	Utilized roadrunner to make a more complex and consistent autonomous.

Robot Design

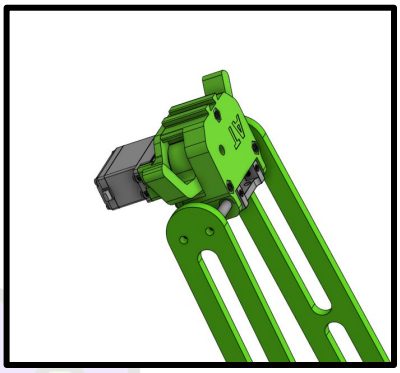
Innovate

Highlights of Robot Continuity and Change Over Time

Our intake:

- Originally used boot wheels to pull samples into box
- The box rotated to allow us access to the middle of the submersible
- Slides attached to intake allows us to extend far into the submersible

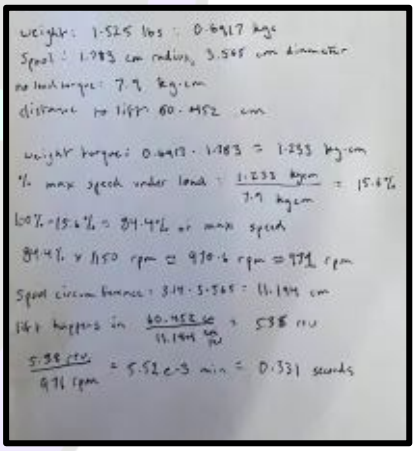
Engineering Challenge: Intake struggled to grab pieces from the floor.
Solution: We recorded slow motion videos of the intaking process to decide where the intake struggled. After deciding that the intake was struggling to lift samples over it's edge, we decided to re-design to an intake that used side spun wheels with no bottom. Because the new design had no lip to get over, the intake was able to intake much more quickly and consistently.



Our outtake:

- Intake bucket transfers to outtake bucket which has a lid that closes
- We used slides run by string to reach the high bucket
- Outtake bucket rotates to other side of robot
- Lid opens and sample drops into high bucket

Engineering Challenge: Slides were not going up as fast as we intended
Solution: We started by calculating the speed at which the slides should go up, and made sure we had enough torque. After that, we used oil to make the slides smoother, and made sure to prevent any string from rubbing



Our goals:

- Be able to score in high bucket-1st Competition
- Be able to score both samples and specimens-2nd Competition
- Have 2nd level hang-States

How our robot design achieves those goals

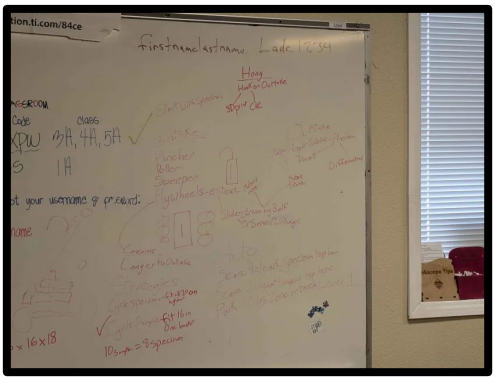
- We use a compact footprint to reduce area and give us more room to work within the size limitations
  - Keeps our robot light for hang
  - Makes it easier to reach inside of submersible
- Our drive train design allows easy mounting for all mechanism to allow easy redesigns as competition goes on

How we mitigate the risks of our design

- With careful pocketing we made each load bearing point have 2 supports
- We used thicker struts to maintain structural integrity
- Use CAD to test for errors before actual build

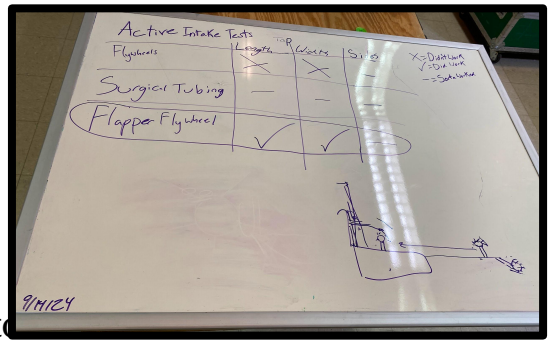
Engineering Process Highlight: Intake Mechanism

Think



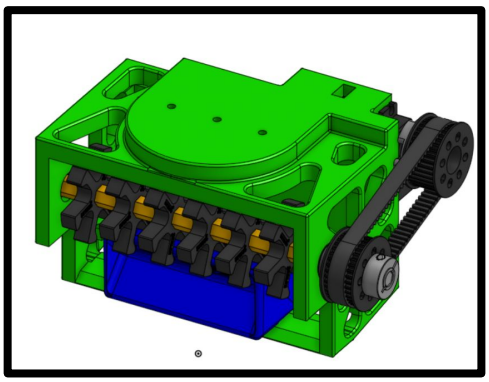
Problem Scoping:

- The intake was envisioned to pull samples in using spoked wheels.
- Right from the beginning, it was clear to all members that intake was a direct factor of the robot's success, especially since the 2024 game's design placed game pieces within a barrier. It was also clear that intake design needed to be able to pick up randomly distributed pieces, with speed and efficiency



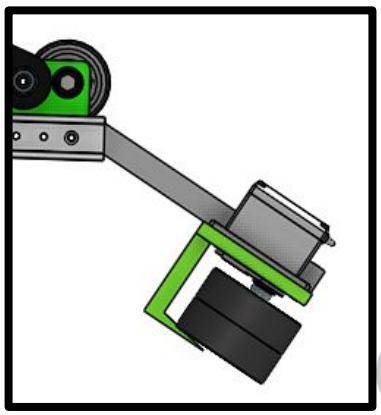
Design Prototype:

- Early designs for the intake used a drill to replace a motor.
- These designs involved using surgical tubing as a method of intake, but after extensive testing and comparison with flywheels, the team decided to discard the surgical tube idea
- The team still uniformly stood against claw intake, since it would require immense amounts of precision on behalf of the driveteam, and was deemed harmful to our overarching goal.



Design:

- Designed the initial version of the intake, which used an Axon Mini servo to power 3 inch diameter boot wheels.
- One issue this design faced was that the boot wheels were too flexible, leading to it struggling to intake the samples.
- Other issues included being very large and bulky, and therefore heavy as well as using unnecessarily large wheels.



Re-design:

- Our Intake re-design features two horizontal compliance wheels powered by superspeed servos.
- We chose this design after looking at a variety of different intake designs online, because it was simple and compact
- This style of intake allowed for an easy to transfer into our redesigned claw outtake system.

Engineering Process Highlight: Intake Mechanism

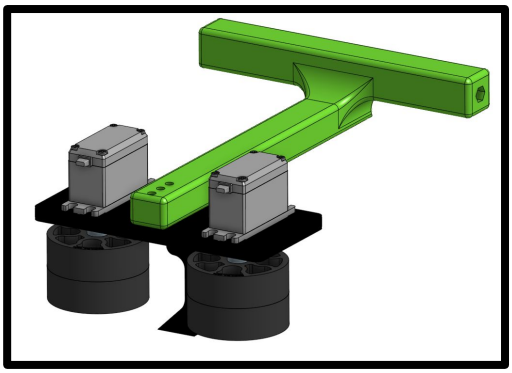
Think

Retest:

- After mounting our redesigned intake, we begin to stress test it.
- We did this by replicating ways the intake could be damaged in a match, such as slamming into another robot or the wall.
- From this, we learned that we needed to increase support on certain parts of the intake, as well as increasing the infill when 3D printing it.

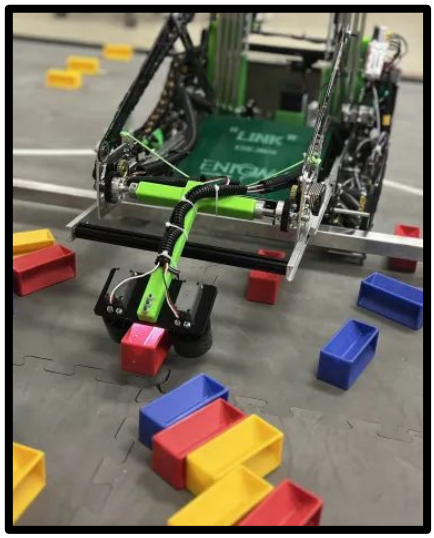
Finalize:

- After Stress testing the intake, we decided that the intake needed to be printed with a higher infill.
- Additionally, we decided to improve the width of intake to prevents breaks
- Finally, we decided to lower the intake ramp in order to ensure that it more consistently went in.



Deployment:

- After finalizing our intake design, we printed our final version and mounted it to the robot
- In testing and in practice matches it has performed very well
- The intake has had no issues with breaking, and has stayed working consistently throughout practice.



Conclusions:

- Our intake design evolved from a heavy and bulky box intake to a lighter and more compact intake.
- Improvements to our intake allowed for us to greatly speed up our cycle speed and improve our general robot performance.

Skill Development and Mentors

Think and Connect

Lessons Learned

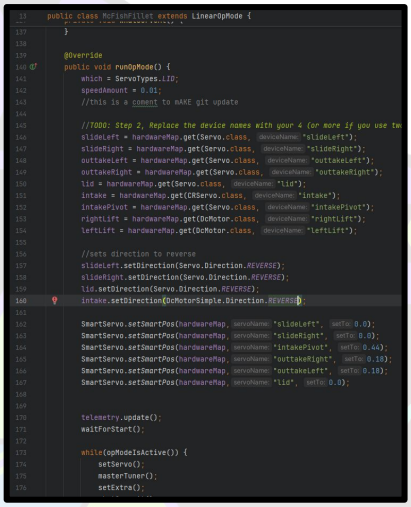
- Younger students shadow older students
- We use Onshape CAD Classes
- Use old robots to develop skills

Mentors in Team ENIGMA

How We Find Our Mentors:

- Outreach events
- Parents
- Friends of students or parents
- FIRST Alumni

What our Mentors Taught Us:



Coding

- How hashmaps work
- How static variables work
- How to make enumeration
- How to debug errors
- Good Coding Habits

Build

- How to create part studios in CAD
- How to create assemblies in CAD
- How to string slides

Current Enigma Mentors:

Gray

- ENIGMA FTC and FRC Alumni
- CAD and Build Mentor

Peter

- ENIGMA FRC Alumni
- CAD and Build Mentor

Felix

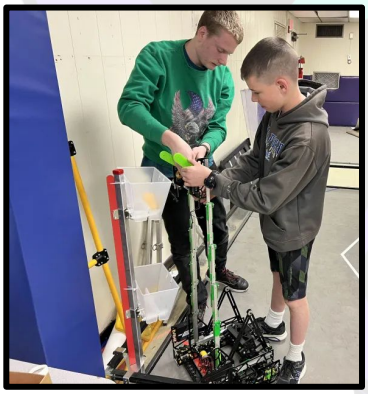
- ENIGMA FTC and FRC Alumni
- Build Mentor

Dave-

- ENIGMA Parent
- Code Mentor

Morgan

- FIRST Alumni
- Outreach and Portfolio Mentor



Goals and STEM Connections

Connect

Season Goals

- Build competitive robot
- Spread STEAM
- Expand FIRST

Steps to Reach Goals

- Managed time wisely, continue to make improvements
- Promote STEAM at all outreach events to try and get kids involved in any form of STEAM
- Host FIRST Lego League Qualifier so Albuquerque teams can compete
- Mentor other teams such as FLL team at Desert Ridge and new FTC team-27413 SPQR

Science, Technology, Engineering, and Math Connections

We worked with:

- Matt Williams- Mechanical Engineer
- Isaiah Natoni-Mechanical Engineer

This helped us by:

- Giving us feedback on our robot to help fix errors

We plan to work with:

- Plan to attend Sandia National Labs Kids Day

SMART Goals					
Goal	Specific	Measurable	Achievable	Relevant	Time-Bound
Build Competitive Robot	We as a team need to build a competitive robot through planning, build, and code	Top 100 Offensive Power Ranking in the world according to FTC Scout by performing well with alliances	Our goal is achievable based on past seasons	Increased acknowledgement across the country means more opportunities to learn from world class teams	Reach top 100 OPR by the end of the regional competition
Reach World Competition	We want to receive an invitation to the worldwide FIRST competition from our Regional Competition	We will receive an invitation at the end of Regional Competition	Our goal is achievable based on past seasons performance	Allows us to learn from world class teams for better improvement next year	Have an invitation by end of Regional Competition

ENIGMA Robotics Outreach Timeline:

Motivate and Connect

5/3/2024: Spring Maker Faire

- Demonstrated Robots to La Academia De Esperanza Charter School
- 2nd year participating

5/4/2024: Homeschool Resource Fair

- Demonstrated Robots to home school students to help increase interest in STEM
- 2nd year participating

5/11/2024: Fundraising/Outreach Event for Barnes and Noble

- Showed off our robots to increase interest in STEM
- Fundraised around $2000 from that days book sales
- Estimated 300 people

5/21/2024: Technology Leadership High School Networking Event

- Robot Demonstration

6/2/2024: ENIGMA Robotics participated in a FIRST robotics exposition at the Albuquerque Isotopes baseball stadium

- Partnered with FRC team 4153 (Project Y), 6974 (Zia Robotics), 9080 (ENIGMA) and FTC teams 10348 (GearMasters), and 20334 (Geared Up) to present FIRST competitions and offerings.
- 2nd year participating
- Isotopes draw in over 6,700 people per game, giving us a large reach

8/22/2024: Manzano High School Open House

- ENIGMA, along with FRC team 8512, participated at Manzano High School's open house to present FIRST Robotics, and promote STEM at the community level.
- Estimated 200 people

9/30/2024: Fundraising at Panera Bread

- ENIGMA showcased 2024 FTC team design work and CAD, and presented the 2023 FTC robot (Mantis) to executives at the Xfinity branch office in Albuquerque

Current Outreach Projects by ENIGMA Robotics:

Motivate and Connect

We have improved outreach events from last year by bringing robots kids can drive so we are not just talking at them. For the ALbuquerque FLL Qualifier we improved by spreading out the schedule so their is not wasted time and by bringing robots as demonstrations.

ENIGMA mentors 3 FIRST Lego League 2024/2025 season teams at Desert Ridge Middle School

- Teams: 60661 (Xyelodontophis Uluguruensis), 60662 (Python) , 62560 (Robotics - Taylor's Version)
- Mentored by Co-Captain Callahan Williams
- 2nd year
- Estimated 20 kids weekly

ENIGMA mentors 5 other 2024/2025 season robotics teams at Desert Ridge Middle School

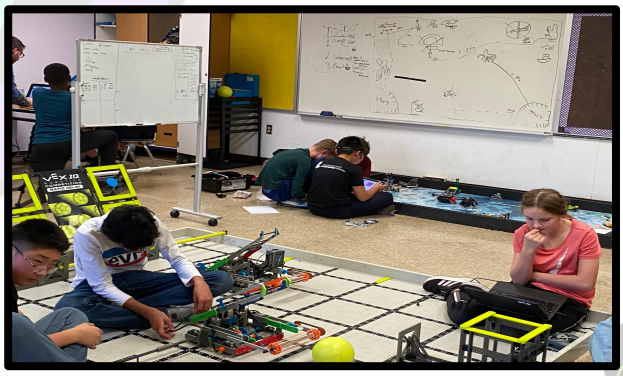
- Mentored by Co-Captain Callahan Williams
- Estimated 40 kids weekly

Rookie FTC team 27413 (SPQR Robotics) is also mentored by ENIGMA

- ENIGMA provides technical support, code support, and also provides the team with tools, robot parts, workshop space and parts manufacturing if needed (3D-printing, CNC milling)

ENIGMA Hosts First Lego League Albuquerque Qualifier

- Paid for access to the venue, provided food and drinks for the volunteers, ran concessions.
- Students, parents, and mentors volunteered to help run the event along with FTC 23794
- Recruited other volunteers to help fill additional roles.
- 2nd year hosting
- Estimated 600 people



ENIGMA Business - SWOT ANALYSIS

Motivate

A SWOT Analysis is a strategic way of planning that is designed to help organizations and individuals, to identify internal and external factors that can impact their goals and objectives.
Benefits of a SWOT Analysis:

a. Simplify large amount of data in an easy to visualize way
b. Promotes communication
c. Helps us see different perspectives
d. Doesn't cost us any money to do.

Strengths	Weaknesses
• Community-based (frequent/flexible meetings) • Intense student commitment • Team works well together • Very organized • Access to tools and machinery • Not opposed to change • Experienced members	• Lack of engineering connections • Lack of programming experience • Little experience with CAD softwares
Opportunities	**Threats**
• 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	• Loss of students • Prevented by: Allowing everyone to participate in what they want to do • Loss of mentors • Prevented by: Always recruiting new mentors and helping mentors feel a part of our family • Loss of funding • Prevented by: Keeping good relations with past sponsors, and reaching out to new possible sponsors. • Experienced students aging out • Prevented by: Constant recruiting • Injury • Prevented by: Making sure to take all safety precautions such as safety glasses

Engineering Connections & Marketing

Connect and Motivate

Verus Research - Employees at Verus Research, Jake and Aaron visited our shop and took a look at our robot and CAD, offering feedback and suggestions on how to improve. Although we were not able to implement their suggestions before competition, some of their ideas for improvement included a winch based climb.

Bomb Squad Demonstration- Members of the Albuquerque Police Department's Bomb Squad brought and demonstrated 3 of their robots and several drones. One of these robots was a robot the bomb squad had made themselves. Along with several other teams including FIRST Lego League & FIRST Robotics Competition teams were able to ask them questions and show our robots to them. They talked to us about the real life impacts of what we are doing in FTC particularly real life use of CAD

We cater to every team member's interests in unique ways as we allow younger, developing team members to practice and expand their mechanical engineering and design skill. These younger members were allowed to retrofit the 2023 ENIGMA robot Mantis. Additionally, like our robot, our team is modular – that is, it is split into smaller sub-systems designed to develop every member regardless of experience level. At ENIGMA, we are immense believers in mentoring as another way of learning, which means no matter the level of years of experience, our team members are constantly engaged and learning.

ENIGMA created many marketing items, including buttons and awards for competitions. These materials revolved around the FIRST DIVE theme, promoting both team ENIGMA and the FIRST Organization as a whole.

ENIGMA team leadership has also made effective fundraising/financing effort plans, including set strategies for reaching out in the community to find corporate and philanthropic partners and sponsors.

Planning and Contributions

Motivate

Individual Contributions and Lessons Learned

Code Team (Elliott, Jet, Loralei, Rose, Sammy):
- Worked all season long on coding last year's robot so they would be prepared to code this year's robot faster

Build Team (Luke, Anirudh, Cody, Phillip, Callahan):
- Worked to learn CAD to help the designing of the robot; built the robot

Managerial Team (Cody, Callahan):
- Made the portfolio, presentation, buttons, and awards for the alamogordo qualifier

As a Team:
- We learned that we need to work together, manage our time, and to be on task

Organizational Plan

Fundraising
- Make budget
- Fundraise $19,620
- Lower spending by being resourceful with parts

Risk Management
- Using Computer Aided Design (CAD) discover mechanical issues before beginning build

Outreach and Service
- Reach out to our community as much as possible and give demonstrations where ever possible

Member	Contributions
Luke	Worked on CAD for drivetrain, intake, and outtake arm mechanism. Helped to build robot, especially drivetrain and slides.
Cody	Designed this season's pins, jerseys, and other team identity materials. Helped design an early intake model and modified the robot's decorative elements.
Elliott	I helped lead the code team, and also mentored developing members of the programming team
Jett	I helped debug/fix code, using the rubber ducky debugging method.
Gabriel	I helped with our wire management
Phillip	I helped CAD initial intake design. I helped put together the robot
Davy	Wrote experimental code to move intake over a sample. Organised parts of shop
Sammy	Worked on Code to help drivers quickly turn around. Worked on software limits of lift mechanism.
Loralei	I helped work on first iteration of teleop code.
David	I helped build the outtake slides and some other parts. I came up with an idea for battery cover
Anirudh	Worked on CAD for drivetrain, intake, and outtake arm mechanism. Helped to build robot, especially drivetrain, slides, and intake.
Callahan	I helped others thoroughly think through ideas and helped build the robot. I help strategize with alliances at competition and help the drivers think in matches