2024-2025 INTO THE DEEP Season

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A MESSAGE OF APPRECIATION

“We are grateful for your generous support of our team and our mission.”

Anirudh N. Callie W. Cody S. David M. Davy G. Elliott C. Gabriel G. Jett S. Lorelai C.

Luke C. Phillip M. Rose G. Sammy G. Russell M. Dan C. Renzo D. Gray S. Felix M.

Isabel M. Jacob V. Aaron M. Dave C. Matt W.

About FTC ENIGMA 16265

Enigma 16265 is an 8yr First Tech Challenge Robotics team in Albuquerque, NM. We are a community team working out of the Manzano High School Teen Tech Center,

By the Numbers

15	Student Team Members
3	Primary Robot Subsystems
2	Major Intake Designs
2	High-Speed Lift Motors
2	Odometry Pods
2	Scrimmage Finals
3rd	Trips to Worlds
60	Students Mentored Weekly

Connect with the team

Team Instagram: https://instagram.com/enigma.robotics
Team Facebook: https://www.facebook.com/enigma.robotics.program
Team YouTube: https://www.youtube.com/channel/UCziMRJj5j_hRYlwlJgXOjoQ
Team Website: https://enigmaftc.com/

Students

Anirudh N.

- Team Co-Captain
- Builder
- Fabricator
- Skilled 3D Prints
- Human Player
- Electronics
- Wiring & Soldering
- Skilled Bandsaw
- Learning Java Code
- Outreach
- Fundraising
- Portfolio / Notebook
- Team Spirit
- Team Media
- Drive Team

Callie W.

- Team Co-Captain
- Builder
- Wiring & Soldering
- Electronics
- Drive Coach
- Drive Team
- Human Player
- Assembly
- Outreach
- Fundraising
- Portfolio / Notebook

Cody S.

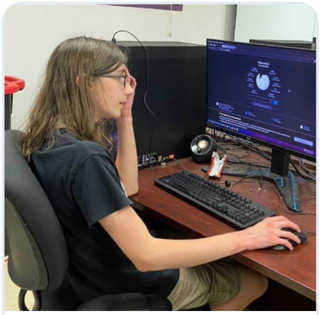
- Graphic Designer
- Social Media
- Outreach
- Fundraising
- Portfolio / Notebook
- Team Spirit
- Team Media
- Assembly
- Rookie Year

David M.

- Portfolio / Notebook
- CAD Designer
- Builder
- Fabricator
- Skilled 3D Prints
- Assembly
- Design & Prototype

Davy G.

- Learning Java Code
- Skilled Java Coder
- Skilled Vision Coder
- Skilled Autonomous Pathing
- Outreach
- Fundraising
- Shop Manager



Elliott C.

- Drive Team
- Human Player
- Skilled Java Coder
- Skilled Autonomous Pathing
- Skilled Vision Coder
- Electronics
- Portfolio / Notebook
- Outreach
- Fundraising

Gabriel G.

- Builder
- Fabricator
- Driver Mechanisms
- Drive Team
- Wiring & Soldering
- Electronics
- Outreach
- Fundraising
- Skilled CNC Mill
- Skilled Bandsaw
- Assembly
- Learning Java Code
- Portfolio / Notebook

Jett S.

- Builder
- Fabricator
- Human Player
- Learning Java Code
- Skilled Blocks Coder
- Electronics
- Skilled Autonomous Pathing
- Portfolio / Notebook
- Outreach
- Fundraising

Lorelai C.

- Team Spirit
- Game Manual Expert
- Judging Awards
- Portfolio / Notebook
- Learning Java Code
- Outreach
- Fundraising

Luke C.

- Team Captain
- CAD Designer
- Builder
- Fabricator
- Drive Team
- Driver Chassis
- Drive Coach
- Assembly
- Wiring & Soldering
- Electronics
- Portfolio / Notebook
- Outreach
- Skilled Bandsaw
- Fundraising
- Driver Mechanisms
- Design & Prototype
- Team Spirit
- Game Manual Expert
- Judging Awards
- Skilled 3D Prints

Phillip M.

- Builder
- Skilled CNC Mill
- Assembly
- Outreach
- Portfolio / Notebook

Rose G.

- Skilled Java Coder
- Skilled Vision Coder
- Skilled Autonomous Pathing
- Portfolio / Notebook
- Rookie Year
- Learning Java Code
- Outreach
- Fundraising

Sammy G.

- Skilled Java Coder
- Skilled Vision Coder
- Skilled Autonomous Pathing
- Learning Java Code
- Portfolio / Notebook
- Team Spirit
- Electronics
- Outreach
- Fundraising

Coaches and mentors

DOD STEM

H

Heather K.
Grant Admin

- Grant Admin
- Grant Liaison

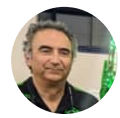
FTC ENIGMA 16265

Russell M.
Coach #1

- Shop Admin
- Build & Fabrication
- Java Programming
- Wiring and Electronics
- Quality Control
- Machine Training
- Systems Mentor
- Design
- Game Strategy
- 3D Prints Mentor
- Media Production
- Robotics Ambassador
- CAD Training
- Mechanical Engineering

Dan C.
Coach #2

- Team Administrator
- Safety Coordinator
- Quality Control
- Game Strategy
- Robotics Ambassador
- Media Production
- Design
- 3D Prints Mentor



Renzo D.
Mentor

- Systems Mentor
- Electrical Engineering
- Build & Fabrication
- Wiring and Electronics
- Quality Control
- Robotics Ambassador
- Game Strategy
- Mechanical Engineering
- Design
- Robotics Control Systems

Gray S.
Mentor

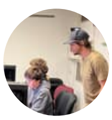
- FIRST Alumni
- Build & Fabrication
- Robot Driving
- Wiring and Electronics
- CAD Training
- Electrical Engineering
- Quality Control
- Game Strategy
- Design
- Mechanical Engineering
- Systems Mentor
- Robotics Ambassador
- Robotics Control Systems
- 3D Prints Mentor

Felix M.
Mentor

- FIRST Alumni
- Mechanical Engineering
- Wiring and Electronics
- Build & Fabrication
- Quality Control
- Electrical Engineering
- Robotics Ambassador
- Game Strategy
- Robotics Control Systems
- Design
- Systems Mentor
- Machine Training

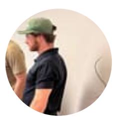
Isabel M.
Mentor

- Robot Driving
- Build & Fabrication
- Java Programming
- Quality Control
- Game Strategy
- Robotics Ambassador
- Robotics Control Systems
- Applied Mathematics
- Computer Science
- Systems Mentor
- Design
- FIRST Alumni



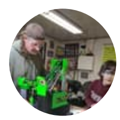
Jacob L.
Mentor

- Build & Fabrication
- CAD Training
- Wiring and Electronics
- Quality Control
- Mechanical Engineering
- Systems Mentor
- Design
- Game Strategy



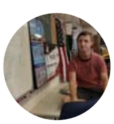
Aaron M.
Mentor

- Build & Fabrication
- Quality Control
- Wiring and Electronics
- CAD Training
- Mechanical Engineering
- Systems Mentor
- Game Strategy
- Design



Dave C.
Mentor

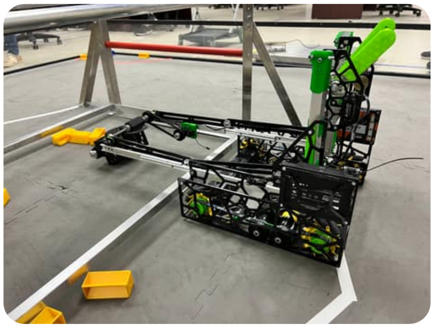
- Java Programming
- Game Strategy
- Computer Science
- Quality Control
- Applied Mathematics



Matt W.
Mentor

- Systems Mentor
- Quality Control
- Applied Mathematics
- Mechanical Engineering
- Game Strategy
- Design
- CAD Training
- Robotics Control Systems

Robot showcase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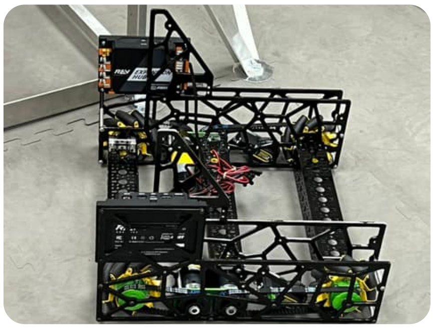
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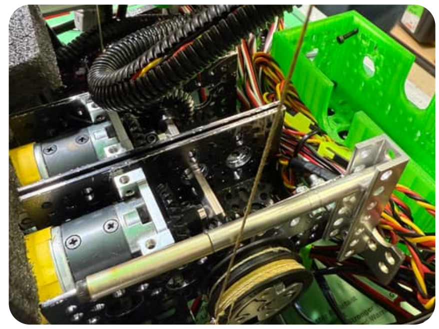
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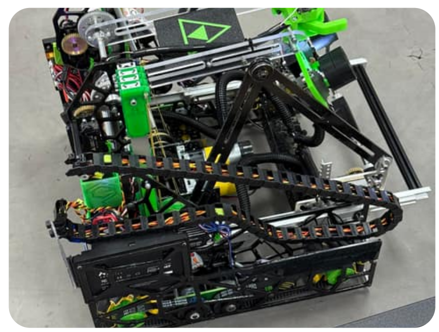
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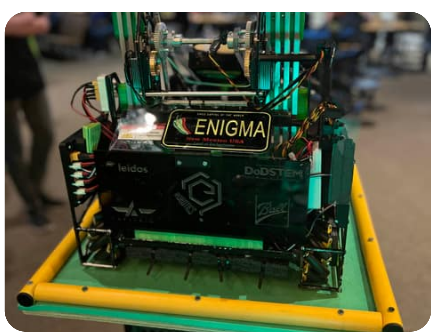

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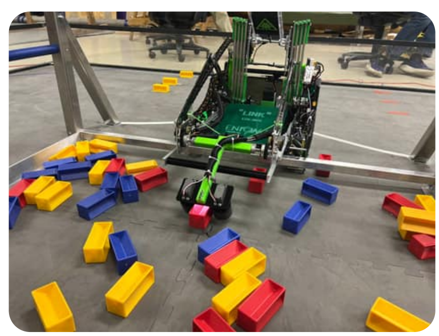
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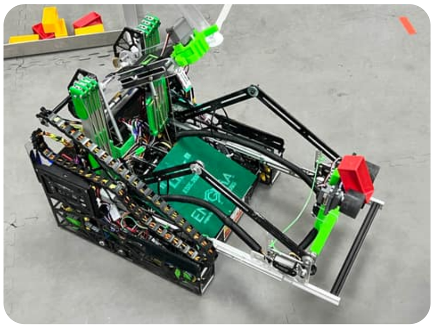
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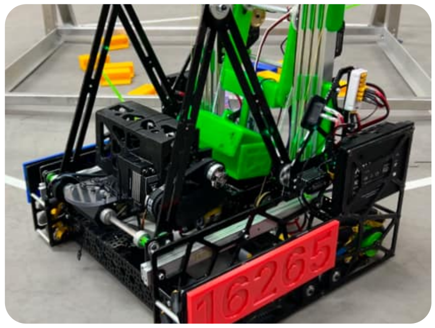

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Year in review

INTO THE DEEP · Robot: Link

OUR SEASON

Meeting the INTO THE DEEP ChallengeINTO THE DEEP presented teams with two major game-piece types and several different scoring objectives.

Robots could collect colored samples from the field and submersible, score samples in baskets, manipulate specimens, place specimens on the chamber, and attempt increasingly difficult ascent levels during the endgame.

ENIGMA evaluated the scoring opportunities and decided that cycling samples into the baskets—especially the high basket—offered the best path toward consistent points.

That strategic choice shaped nearly every part of Link.

The robot needed to:
Reach over the walls surrounding the submersible.
Collect samples from unpredictable positions.
Transfer them into the robot quickly.
Raise them to the height of the high basket.
Deposit them reliably.
Remain compact and light enough to pursue an ascent.
Allow major mechanisms to be redesigned as the season progressed.
Link’s Modular ArchitectureLink was divided into three primary subsystems:
Drivetrain
Intake
Outtake
Each subsystem could be assembled, tested, removed, and revised with limited disruption to the rest of the robot.

This modular approach became one of the most important decisions of the season.

At the Alamogordo Scrimmage, both the original intake and outtake struggled. On a robot built as one tightly interconnected structure, replacing both systems might have required a near-complete rebuild. Link’s architecture allowed the students to remove the mechanisms and replace them with improved designs.

The drivetrain used a custom parallel-plate mecanum design. Pocketed structural plates reduced weight while providing mounting locations for the intake, outtake, electronics, and other components.

The open internal layout also improved serviceability. Students could reach wiring and mechanisms more easily, shortening repair time between matches.
Extending Into the SubmersibleThe walls surrounding the lower section of the submersible created an immediate engineering problem.

A fixed intake positioned only at the front of the drivetrain would have limited access to samples deeper inside the structure. ENIGMA therefore placed the intake on an extending slide and arm system.

This allowed Link to reach over the barrier and bring its active intake closer to game pieces that would otherwise remain inaccessible.

The extending intake shortened the distance the drivetrain needed to travel and gave the drive team more flexibility when samples were scattered randomly inside the submersible.
The Original IntakeThe first intake concept used an enclosed box with flexible boot wheels.

The box could rotate and extend into the submersible. In theory, the wheels would pull a sample into the enclosure and retain it for transfer.

In practice, several problems emerged:
The boot wheels were overly flexible.
The intake was large and heavy.
Samples struggled to climb over the lower edge.
The enclosed design created additional friction.
The mechanism required more precise alignment than expected.
Transfer into the next subsystem was inconsistent.
The team also experimented with surgical tubing and early prototypes powered by a drill in place of the final motor or servo.

Testing showed that surgical tubing did not perform as well as the team hoped. The students compared it with flywheel-style concepts and chose to continue development with powered wheels.
Using Slow-Motion VideoOne of the season's best examples of the engineering process came when the team recorded slow-motion video of the intake.

At full speed, it was difficult to see exactly why samples were failing to enter. The slow-motion footage showed that the game pieces were striking the intake's edge and struggling to climb into the enclosed box.

That evidence changed the team's understanding of the problem.

The primary issue was not simply insufficient wheel speed or grip. The geometry itself created an unnecessary obstacle.

The team redesigned the intake around two horizontally oriented compliant wheels with no enclosed bottom lip. Because the sample no longer needed to climb over a large edge, it could move directly between the wheels and into the transfer area.

The revised design was:
Smaller
Lighter
Simpler
Faster

More consistent
Easier to transfer from
Less dependent on perfect driver alignment
Stress Testing the New IntakeAfter installing the redesigned intake, the team did not limit testing to ideal collection cycles.

Students intentionally recreated impacts that might occur during competition, including collisions with the wall and contact from another robot.

The stress testing revealed areas that needed reinforcement.

The team increased the infill of 3D-printed components, widened vulnerable sections, added structural support, and lowered the intake ramp to improve sample entry.

The final version survived repeated testing and remained reliable during practice.

This process taught the team that testing should not merely prove that a mechanism works. Testing should actively search for how and where it will fail.
High-Basket OuttakeAfter the intake collected a sample, Link transferred it into the outtake.

The outtake used a container or claw arrangement mounted to continuously strung vertical slides. Two high-speed motors powered the slides to reach the high basket.

Scoring in the high basket was selected because the team calculated that it offered the most efficient point opportunity within Link’s intended cycle strategy.

The mechanism moved through several stages:
The intake collected a sample.
The sample transferred into the outtake.
The outtake secured the game piece.
The slides extended to the required height.
The outtake rotated toward the basket.
The lid or retaining mechanism opened.
The sample dropped into the basket.
The slides returned for the next cycle.
Improving Slide SpeedThe team found that the slides did not initially rise as quickly as expected.

Students first calculated the theoretical lift speed and reviewed whether the motors provided adequate torque.

They then examined mechanical losses.

The team identified friction in the slides and places where string could rub against surrounding components. Students lubricated the slides, corrected string routing, improved alignment, and reduced unnecessary resistance.

The experience reinforced that a mechanism can have sufficient theoretical power and still perform poorly when friction, binding, misalignment, or string routing consumes that power.
Continuously Strung SlidesLink's lift used a continuous string arrangement.

Instead of powering each slide stage independently, the string system allowed the stages to extend together while keeping the drive components relatively compact.

Students learned how to:
Route lift string.
Maintain appropriate tension.
Prevent the string from crossing or rubbing.
Align slide stages.
Reduce binding.
Balance speed against torque.
Set software limits.
Inspect the mechanism before matches.
The slide system gave Link the height required for high-basket scoring while allowing the robot to remain compact when retracted.
Sample and Specimen DevelopmentENIGMA established progressive robot goals:
Score in the high basket by the first competition.
Score both samples and specimens by the second competition.
Develop a Level 2 ascent by the New Mexico Championship.
The robot was initially built around sample cycling, but students continued expanding its capabilities as the season progressed.

The intake used compliant wheels for sample acquisition, while the outtake claw and lift architecture provided a foundation for specimen handling.

Not every goal reached the same level of reliability, but the phased plan gave the students clear development priorities rather than attempting every task at once.
Color-Sensing DevelopmentLink occasionally collected the wrong color sample.

To address this, the programming team added a color sensor and developed code that could identify an incorrectly colored game piece.

The long-term goal was for Link to reject or outtake the wrong sample automatically.

This introduced students to several practical sensing challenges:
Sensor placement
Lighting conditions
Distance from the sample
Differences between colors
Threshold selection
False readings

Timing the response

Integrating the sensor with the intake state

The color sensor represented an important step toward making the robot respond to its environment rather than relying entirely on driver observation.

Odometry and Road RunnerLink's early autonomous performance at the Alamogordo Scrimmage was inconsistent.

The team responded by installing goBILDA odometry pods and developing Road Runner-based autonomous pathing.

The odometry wheels rolled freely against the field and measured Link's motion using encoders. This data gave the software a more useful estimate of the robot's position than relying only on the powered mecanum wheels, which could slip during acceleration, strafing, or turning.

Students used Road Runner and MeepMeep to create and visualize autonomous paths before testing them on the physical robot.

The code team developed a two-specimen autonomous routine and worked to make Link's movement more accurate and repeatable.

Racing the Autonomous ClockAs Link's autonomous routine became more ambitious, the team encountered a new problem: the sequence could perform the intended actions, but it was sometimes running out of time.

The programmers reviewed the routine one action at a time and identified movements, pauses, and mechanism transitions that could be completed more quickly. They shortened delays, increased the speed of selected actions, and refined the order in which mechanisms operated.

The team also used Road Runner to develop a more complex and consistent autonomous path. Odometry gave Link better position feedback, while MeepMeep allowed students to visualize the intended motion before testing it on the physical robot.

This work taught the programming team that autonomous development is not only about reaching the correct location. Every movement must fit within a strict time limit, leaving little room for unnecessary pauses or inefficient mechanism sequencing.

Planning Automatic Sample AcquisitionThe team identified automatic claw operation as a possible future improvement.

By placing a distance sensor near the claw, Link could detect when a sample had been positioned correctly and close the claw automatically. This could reduce driver workload and make transfers more consistent.

Although the feature was not fully implemented during the season, developing the concept helped students think about how sensors could convert a manually operated mechanism into a responsive robotic system.

Autonomous SimulationMeepMeep allowed students to see a virtual representation of Link's intended autonomous path.

This helped the team:

Visualize trajectories.

Estimate where turns should occur.

Check whether routes crossed field obstacles.
Plan mechanism timing.
Compare alternative paths.
Begin development before every physical mechanism was complete.
Simulation did not replace physical testing, but it made physical testing more purposeful.
Software OrganizationThe code team created reusable classes describing how Link's motors, servos, and mechanisms operated.

The drivetrain code combined three driver inputs:
Forward and backward movement
Side-to-side strafing
Rotation
The program then normalized the motor powers when the combined commands exceeded the allowable range.

Students also learned about:
Hash maps
Static variables
Enumerations
Debugging
Reusable methods
Software limits
Tele-operated control
Autonomous sequencing
Good coding habits
Some programmers practiced on the prior season's robot so they could develop skills before Link was ready.
A Purposeful AestheticLink's visual design reflected ENIGMA's identity.

The robot combined bright green 3D-printed components with black CNC-machined structural parts. The drivetrain plates were pocketed both to reduce weight and to create a deliberate, engineered appearance.

The team viewed aesthetics as more than decoration. A clean and organized robot made mechanisms easier to understand, improved presentation to judges, and demonstrated attention to detail.
Alamogordo ScrimmageThe Alamogordo Scrimmage was Link's first major field test.

The event revealed that the initial intake and outtake were not yet reliable. Autonomous performance also needed substantial improvement.

Rather than viewing the event as a failure, the students treated it as a full-scale engineering test.

Link's modular design allowed the team to replace the intake and outtake after the event. The programming team added odometry and began developing a more accurate autonomous routine.

Despite the mechanical challenges, ENIGMA captained an alliance that reached the finals, finishing as the Finalist Alliance Captain.

The event showed both sides of the team's season: Link still had serious weaknesses, but the students could compete, diagnose problems, and leave with a clear redesign plan.
Albuquerque ScrimmageThe Albuquerque Scrimmage showed how much the team had improved.

With revised mechanisms and better software, Link performed more consistently. ENIGMA captained the Winning Alliance and won the robot competition.

The team also earned the Inspire Award, recognizing its overall strength across robot performance, engineering, outreach, teamwork, professionalism, and presentation.

Winning both the tournament and Inspire Award demonstrated that the redesign work following Alamogordo had transformed the season.
New Mexico ChampionshipThe New Mexico Championship was held February 7–8, 2025.

ENIGMA finished qualification matches ranked eighth out of 16 teams.

During alliance selection, the first-ranked team selected ENIGMA as its first partner. The alliance won its opening playoff match, lost in the upper bracket, recovered with a lower-bracket victory, and reached the championship final.

ENIGMA finished as the first-selected member of the Finalist Alliance.

The team also earned second-place Inspire Award recognition.

The Championship result advanced ENIGMA to the 2025 FIRST Championship, marking the team's third trip to Worlds.
Third Trip to WorldsAt the 2025 FIRST Championship in Houston, ENIGMA competed in the 64-team Franklin Division.

The team played ten qualification matches against teams from across the United States and around the world. ENIGMA recorded four visible match victories in the published schedule and finished ranked 50th in the division.

Link and the students faced a much higher competitive standard than they had encountered in New Mexico. Championship-level robots completed faster sample and specimen cycles, executed advanced autonomous routines, performed more reliable ascents, and combined alliance strategies with very little wasted movement.

The team did not advance to the division playoffs, but Worlds provided an opportunity to study designs, exchange ideas, represent New Mexico, and understand the improvements required to become internationally competitive.
A Season Defined by IterationINTO THE DEEP was not a season in which the first robot concept worked perfectly.

Its importance came from the opposite experience.

The original intake struggled. The outtake needed replacement. Autonomous was inconsistent. Slide speed was below expectations. Samples caught on edges. Printed parts needed reinforcement. Transfer required refinement.

At every stage, the students responded by gathering evidence, changing the design, and testing again.

Link became a better robot because the team was willing to admit when an idea was not working.

That ability—to separate pride in the team from attachment to a particular design—was one of the most important accomplishments of the season.

GOALS

Build a Competitive RobotENIGMA’s primary technical goal was to build a robot capable of competing effectively within New Mexico and earning another trip to the FIRST Championship.

The team defined a competitive robot as one that could:
Reach into the submersible.
Collect samples consistently.
Transfer game pieces reliably.
Score in the high basket.
Contribute to specimen scoring.
Complete useful autonomous tasks.
Perform an ascent.
Survive repeated competition.
Be repaired quickly.
Adapt as strategy changed.
Prioritize High-Basket Sample CyclingThe team determined that cycling samples into the high basket provided the best match strategy for Link.

This goal influenced the intake reach, transfer architecture, slide height, outtake design, and autonomous development.

The team’s strategy emphasized repeatable cycles rather than building a robot that attempted every possible task but performed none consistently.
Score in the High Basket by the First CompetitionThe first major robot milestone was high-basket scoring.

This required the complete chain from intake to transfer to lift to deposit to function together.

The goal was ambitious because success depended on several independently developed subsystems operating as one robot.
Add Specimen Capability by the Second EventAfter establishing sample scoring, the team planned to expand Link’s capabilities to include specimens.

This would make ENIGMA more useful to a wider range of alliance partners and reduce dependence on a single scoring strategy.
Develop a Level 2 AscentThe team wanted Link to complete a Level 2 ascent by the New Mexico Championship.

Keeping the robot compact and reducing weight were important parts of this goal.

Even where the final result did not reach the desired level of consistency, developing toward ascent taught the students

about center of gravity, structure, load paths, motor torque, hooks, and endgame timing.
Build a Top-100 RobotThe portfolio identified a SMART goal of reaching the top 100 in offensive power ranking.

The purpose was not only statistical recognition. Competing at that level would expose the team to stronger alliances, more advanced engineering, and increased opportunities to learn from high-performing programs.
Return to the FIRST ChampionshipAfter attending Worlds during CENTERSTAGE, the team set a goal of earning another invitation.

ENIGMA achieved that goal through its performance and second-place Inspire recognition at the New Mexico Championship.
Improve Autonomous AccuracyThe team wanted to replace inconsistent open-loop movement with odometry-supported autonomous pathing.

Installing tracking wheels, using Road Runner, and visualizing trajectories in MeepMeep were all steps toward more repeatable autonomous operation.
Develop Students Across Multiple YearsENIGMA continued using a progressive student-development model:
Newer students shadowed experienced members.
Students practiced on prior robots.
Members received Onshape CAD instruction.
Experienced students mentored developing builders and programmers.
Alumni returned as technical mentors.
Students gradually assumed leadership responsibility.
The goal was not simply to complete Link. It was to create students capable of designing the next robot.
Expand FIRST in New MexicoThe team set goals to promote STEAM, mentor other teams, host an FLL qualifier, support new programs, and make robotics more accessible to students across the community.
Strengthen Professional ConnectionsENIGMA sought feedback from mechanical engineers and other STEM professionals.

These connections helped students identify design weaknesses, understand professional engineering practices, and see how robotics skills connect to future careers.
Fund the Season ResponsiblyThe team established a fundraising target of $19,620.

Students also planned to reduce expenses through careful reuse of parts, thoughtful purchasing, community fundraising, sponsor development, and efficient manufacturing.

Lessons learned

The First Design Is Only a Starting PointThe season’s most important lesson was that an initial design does not need to become the final design.

Link’s first intake and outtake did not perform as intended. Rather than defending the original concepts, the team replaced them.

Students learned that engineering success depends on improving the solution, not proving that the first idea was correct.

Modularity Makes Change PossibleBecause Link's intake, outtake, and drivetrain were designed as separate subsystems, major changes could be made without rebuilding the entire robot.

The team learned that a few additional mounting holes, accessible fasteners, connectors, and standardized interfaces can save many hours later.
Observe Before ChangingSlow-motion video helped the team understand why the intake failed.

Without that evidence, students might have changed the wheel speed, servo power, or compression while leaving the real geometric obstacle in place.

The lesson was simple: understand the failure before selecting the solution.
Test for FailureThe team intentionally slammed the intake into walls and simulated robot contact.

This testing exposed weak printed parts and insufficient support before those failures occurred in a critical match.

Students learned that a successful test is not always one in which nothing breaks. A controlled failure can reveal exactly what needs to improve.
Friction Consumes PerformanceThe slides had enough theoretical speed and torque, yet still moved more slowly than expected.

String rubbing, slide friction, alignment, and lubrication all affected performance.

Students learned that calculations describe an ideal mechanism. Real mechanisms include losses that must be discovered and reduced.
Strategy Should Guide DesignThe team chose to prioritize high-basket sample cycles.

That strategic decision helped prevent the design from becoming a collection of unrelated mechanisms.

Students learned to ask whether each feature supported the intended match strategy.
Sensors Need CalibrationA color sensor could identify the wrong sample only when lighting, distance, placement, and thresholds were properly considered.

Students learned that installing a sensor is the beginning of the work, not the end.
Autonomous Requires Position FeedbackLink's early autonomous routine was inconsistent.

Adding odometry and Road Runner gave the robot a better way to estimate motion and correct its path.

Students learned why wheel slip and field variation make purely time-based or open-loop autonomous movement unreliable.
Simulation Supports but Does Not Replace TestingMeepMeep helped students visualize paths, but the physical robot still behaved differently because of traction, weight, mechanism timing, and real field tolerances.

Simulation was most valuable when combined with systematic physical testing.
Autonomous Efficiency MattersA successful autonomous routine must do more than perform the correct actions—it

must complete them within the available time.

When Link's autonomous sequence began running long, students analyzed the timing of each movement and mechanism action. They learned to remove unnecessary delays, overlap compatible actions, and increase speed where doing so would not reduce reliability.

The experience showed that autonomous programming involves balancing accuracy, speed, mechanism safety, and available match time.
Professional Feedback May Benefit the Next DesignNot every good engineering recommendation can be implemented immediately.

The feedback from Verus Research included ideas such as a winch-based climbing system, but the team did not have enough development time to redesign Link before competition.

Students learned to preserve these ideas for future seasons rather than dismissing them simply because they could not be used right away.
FTC Skills Have Real-World ApplicationsThe Bomb Squad demonstration showed students that the same concepts used in FTC—CAD, remote control, cameras, mechanisms, electronics, and iterative design—are applied to robots that perform serious public-safety work.

Seeing these machines helped students understand that competition robotics is not an isolated activity. It develops practical skills used in engineering and technology careers.
Everyone Must Work TogetherThe portfolio identified teamwork, time management, and staying on task as major lessons.

A complex robot could not be completed by isolated groups. CAD affected manufacturing, manufacturing affected wiring, wiring affected programming, programming affected drive practice, and drive experience revealed new mechanical problems.
Knowledge Must Be SharedYounger students shadowed experienced members, while alumni and mentors taught CAD, coding, debugging, and slide construction.

The team learned that knowledge held by one person is a risk. Knowledge shared across the team becomes a lasting capability.
Fundraising Cannot WaitThe cost of competition, travel, parts, and Worlds required early planning.

The team learned to begin fundraising before advancement rather than waiting until a major expense became urgent.
A Difficult Event Can Improve the Entire SeasonAlamogordo exposed weaknesses in Link, but those weaknesses gave the students a clear direction.

The team left knowing what needed to be redesigned.

Without that early struggle, some problems might not have been discovered until the Championship.

Skills and growth

Modular Robot DesignStudents learned to divide Link into independently serviceable systems.

This improved manufacturing, assembly, testing, repair, and iteration.
Parallel-Plate Drivetrain DesignThe custom drivetrain gave students experience with:
CAD
Plate geometry
Bearing placement
Motor mounting
Mecanum-wheel alignment
Structural pocketing
CNC manufacturing
Electronics access
Subsystem mounting
Onshape and CADStudents learned to create part studios, assemblies, mechanisms, and manufacturing-ready designs.

CAD was used to identify interference and structural problems before parts were produced.
CNC MachiningThe black pocketed drivetrain and mechanism plates required students to translate CAD models into manufactured components.

They gained experience with dimensions, tool access, mounting holes, material removal, and structural support.
3D PrintingBright green printed parts gave Link its identity and supported several mechanisms.

Students learned about:
Infill percentage
Print orientation
Wall thickness
Reinforcement
Material limitations
Stress concentration
Fit and tolerance
Iterative reprinting
Intake DevelopmentThe team compared surgical tubing, boot wheels, enclosed boxes, ramps, and horizontal compliant wheels.

Students gained experience in compression, friction, wheel speed, sample geometry, transfer, weight reduction, and driver tolerance.
Slow-Motion AnalysisVideo became a formal diagnostic tool.

Students used it to study interactions too fast to understand during normal observation.
Stress TestingThe intake was subjected to deliberate impact and abuse.

Students learned to evaluate not only normal function but also match survivability.
Slide Design and StringingThe continuously strung lift taught students how to:

Route and tension string.
Align slide stages.
Reduce friction.
Prevent rubbing.
Match motors to loads.
Maintain compact packaging.
Inspect wear.
Torque and Speed CalculationsWhen the lift moved too slowly, students calculated expected speed and reviewed available torque.

They compared theoretical performance with actual results and investigated the difference.
Road RunnerThe code team used Road Runner to plan and execute autonomous trajectories.

Students learned how robot geometry, velocity, acceleration, and position estimates affect path following.
MeepMeep SimulationMeepMeep allowed the programmers to visualize autonomous paths before testing them on Link.

This supported faster iteration and improved communication between programmers and the drive team.
OdometrygoBILDA tracking pods gave students practical experience with dead-wheel odometry.

They learned how encoder measurements can estimate movement independently from powered-wheel slip.
Optimizing Autonomous TimingThe programming team developed experience measuring and reducing the time required for complete autonomous sequences.

Students learned to:
Review the duration of individual commands.
Reduce unnecessary pauses.
Increase movement speed carefully.
Run compatible mechanisms simultaneously.
Compare simulated paths with physical execution.
Balance speed against accuracy and reliability.
Leave time for small field or mechanism variations.
Distance-Based AutomationThe proposed distance sensor for the claw introduced students to automatic game-piece acquisition.

The concept required them to consider sensor position, detection range, threshold values, false readings, and how the claw should respond when a sample entered the correct location.
Presenting Work to Professional EngineersDuring the Verus Research visit, students explained Link's CAD, mechanisms, goals, and current limitations.

This developed their ability to discuss technical work with professionals, receive constructive criticism, and evaluate suggestions without becoming defensive about the existing design.
Public-Safety RoboticsThe APD Bomb Squad demonstration exposed students to robots and drones designed for hazardous real-world environments.

Students saw how professional systems prioritize reliability, operator awareness, remote communication, cameras, durability, and mission-specific mechanisms.
Programming LeadershipElliott helped lead the programming team while mentoring developing coders.

This strengthened the team's ability to transfer knowledge across experience levels and reduced dependence on a single programmer. Teaching younger members also required experienced students to explain code structure, debugging, and design decisions clearly.
Color SensingThe team developed a system intended to identify and reject an incorrectly colored sample.

This taught sensor integration, calibration, conditional logic, and automated response.
Java ProgrammingStudents expanded their knowledge of:
Classes
Methods
Static variables
Enumerations
Hash maps
Reusable code
Debugging
Software limits
Autonomous routines
Tele-operated control
Rubber-Duck DebuggingProgrammers used rubber-duck debugging—explaining code step by step to an object or another person—to uncover faulty assumptions and logical errors.
Software LimitsThe programming team added limits to protect the lift and other mechanisms from exceeding safe movement ranges.

Students learned that software can protect hardware when position and state are tracked correctly.
Drive-Team StrategyDrive-team members learned to:
Reach into the submersible efficiently.
Approach samples from favorable angles.
Coordinate intake and transfer.
Select scoring targets.
Communicate with alliance partners.
Adapt after failed cycles.
Manage endgame timing.
Scout complementary robots.
Judging and PresentationStudents prepared the portfolio, presentation, buttons, and supporting materials.

They learned to explain Link's design process, failures, redesigns, control systems, outreach, and goals within limited judging time.
LeadershipExperienced students helped younger members think through designs rather than simply completing the work for them.

Co-captains organized team responsibilities, drive strategy, business activities, and technical development.
Business and MarketingStudents designed team identity materials, developed fundraising plans, maintained sponsor relationships, and represented ENIGMA at public events.
Mentoring as LearningBy teaching FLL and rookie FTC students, ENIGMA members strengthened their own understanding.

Explaining a mechanism or program required them to organize their knowledge clearly and respond to questions they might not otherwise have considered.
Growth Beyond LinkThe deepest growth came from understanding that engineering is an evidence-driven process.

Students learned to ask:
What is the robot supposed to accomplish?
What is actually happening?
Where does the failure begin?
Can we observe it more carefully?
Is the problem caused by geometry, friction, software, or strategy?
Can the mechanism be replaced without rebuilding the robot?
How do we test the new solution?
How do we make it survive competition?
How do we transfer this knowledge to younger students?
Those questions will remain useful long after Link is retired.

Competitions

NM FTC Alamogordo Scrimmage

Dec 6, 2024 · Alamogordo High School, Alamogordo, New Mexico

5–0 record, 1st Seed, Finalist Alliance Captain

The Alamogordo Scrimmage was ENIGMA 16265's first major competition test of the INTO THE DEEP season and Link's first opportunity to perform on a complete field.

ENIGMA completed qualification matches undefeated with a 5–0 record, ranking first among the nine participating teams. As the top-ranked team, ENIGMA became captain of the first-seeded alliance and selected Team 21797, Hack City, as its alliance partner.

The alliance won the first championship match 116–94 but lost the following two matches, finishing the tournament as the Finalist Alliance.

Although ENIGMA performed well competitively, the scrimmage exposed significant weaknesses in Link's original intake, outtake, and autonomous routine. The intake struggled to pick samples up from the floor, transfer between mechanisms was inconsistent, and autonomous movement lacked the accuracy and speed the team needed.

These problems made Alamogordo one of the most valuable engineering events of the season. Rather than continuing with mechanisms that were not working, the students used the experience to begin a major redesign. Link's modular construction allowed the team to replace the intake and outtake without rebuilding the entire robot, while the programming team began integrating odometry and Road Runner to improve autonomous consistency.

The Finalist Alliance result showed that ENIGMA could remain competitive even while Link was still early in its development. More importantly, the event gave the team clear evidence of what needed to change.

NM FTC Albuquerque Scrimmage

Jan 18, 2025 · La Academia de Esperanza Charter School, Albuquerque, New Mexico

Winning Alliance Captain, Inspire Award Winner

The Albuquerque Scrimmage demonstrated how much Link had improved following the lessons learned in Alamogordo.

ENIGMA again completed qualification matches undefeated with a 5–0 record and ranked first, this time among 13 teams. Link recorded a qualification high score of 161 points, a significant increase from the robot's early-season performance.

As captain of the first-seeded alliance, ENIGMA selected Team 10348, Gear Masters, as its partner.

The alliance won its opening playoff match 143–97, advanced through the upper bracket with a 182–92 victory, and won the championship match 138–98. ENIGMA finished the event as the Winning Alliance Captain.

The team also earned the Inspire Award, the highest overall judged honor in FIRST Tech Challenge. The award recognized ENIGMA's combined strength in robot performance, engineering, outreach, mentorship, teamwork, planning, and presentation.

The event marked a major turnaround from Alamogordo. Link's redesigned intake and outtake were more reliable, the team's autonomous development had advanced, and the robot was becoming a stronger high-basket sample-cycling machine.

Winning both the robot competition and the Inspire Award confirmed that the students had not merely repaired Link—they had improved the entire program.

New Mexico FTC Championship

Feb 8, 2025 · Menaul School, Albuquerque, New Mexico

Finalist Alliance 1st Pick, 2nd Place Inspire Award

The New Mexico FTC Championship brought together 16 teams competing for two advancement positions to the FIRST Championship.

ENIGMA completed qualifications ranked eighth. The team recorded two qualification wins and three losses, including a 171-point victory with Team 24685, the Lovington Black Kats.

Although the qualification ranking was lower than ENIGMA had achieved at the two scrimmages, Link's capabilities and the team's experience remained valuable during alliance selection. The first-ranked team, Team 24685, Lovington Black Kats, selected ENIGMA as its first alliance partner.

The alliance opened the playoffs with a 242–155 victory. After a narrow 177–154 loss in the upper bracket, the alliance recovered with a 209–86 lower-bracket victory to earn a place in the championship match.

In the final, the alliance faced Team 12887, Devolt Phobos, and Team 15909, Lovington RoboCats. ENIGMA's alliance finished only 14 points behind, losing 195–181 and ending the tournament as the Finalist Alliance.

ENIGMA completed the playoffs with a 2–2 record and was recognized as the first team selected to the Finalist Alliance.

The team also earned second-place Inspire Award recognition. That judged result secured ENIGMA's invitation to the FIRST Championship in Houston, marking the team's third trip to Worlds.

The championship reflected the value of being a complete FIRST team. Although ENIGMA did not win the robot competition or finish near the top of qualifications, its engineering, outreach, mentorship, organization, presentation, and season-long impact earned advancement to the international stage.

FIRST Championship — Franklin Division

Apr 5, 2025 · George R. Brown Convention Center, Houston, Texas

3–7 record, 50th out of 64 teams

ENIGMA represented New Mexico at the 2025 FIRST Championship and competed in the 64-team Franklin Division. This was the team's third appearance at Worlds.

The Championship placed Link on the field with teams from across the United States and around the world. ENIGMA played ten qualification matches and finished with a 3–7 record, ranking 50th out of 64 teams.

The team earned victories with scores of 323–264, 303–278, and 297–227. Several other matches demonstrated the much higher scoring level present at Worlds, with opposing alliances regularly exceeding 300 points.

Link and the students faced robots with faster sample and specimen cycles, highly developed autonomous routines, reliable endgame ascents, refined transfer mechanisms, and strong alliance coordination.

ENIGMA did not advance to the Franklin Division playoffs, but the Championship provided experience that could not be duplicated within the regional season. Students studied world-class robot designs, exchanged ideas with other teams, represented their sponsors and New Mexico, and saw how small differences in speed, reliability, autonomous performance, and cycle efficiency affect results at the highest level of FTC.

The event completed a season defined by growth. Link had progressed from an early robot with unreliable intake, outtake, and autonomous systems into a machine capable of competing at the FIRST Championship.

Worlds also gave ENIGMA a clearer picture of the next level. Regional success had earned the opportunity to attend, but international competition showed where the team would need to improve to become consistently competitive on the world stage.

Outreach

Total people reached: 8,225

Total volunteers: 84

Spring Maker FaireENIGMA demonstrated robots at La Academia de Esperanza Charter School’s Spring Maker Faire.

The event gave students an opportunity to explain FIRST programs and allow visitors to see competition robots in person.

This was the team’s second year participating.
Homeschool Resource FairENIGMA demonstrated robots for homeschool students and families.

The team used hands-on robotics to show that FIRST can provide engineering, programming, teamwork, leadership, and competition opportunities outside a traditional school program.
Barnes & Noble Fundraiser and Outreach EventAt Barnes & Noble, the team combined fundraising with public engagement.

Students demonstrated robots, discussed FIRST, and interacted with an estimated 300 visitors.

The event generated approximately $2,000 through the day’s book sales.
Technology Leadership High School Networking EventENIGMA participated in a networking event at Technology Leadership High School and provided a robot demonstration.

Students shared their work with educators, community members, and other young people interested in technology.
Albuquerque Isotopes Robotics ExpositionENIGMA joined FRC Teams 4153, 6974, and 9080, along with FTC Teams 10348 and 20334, for a FIRST robotics exposition at an Albuquerque Isotopes baseball game.

The participating teams demonstrated multiple levels of FIRST and showed visitors how students can progress from introductory robotics through FTC and FRC.

An Isotopes game can draw more than 6,700 people, giving the exposition one of the season’s largest potential audiences.
Manzano High School Open HouseENIGMA and FRC Team 8512 represented FIRST Robotics at Manzano High School’s open house.

The teams introduced students and families to robotics and encouraged new participation.

The event reached an estimated 200 people.
Panera and Xfinity OutreachThe team participated in a Panera fundraising event and presented its design work, CAD, and previous robot Mantis to representatives connected with the local Xfinity office.

These interactions combined fundraising, technical presentation, and professional networking.
Desert Ridge FLL MentoringENIGMA mentored three registered FIRST LEGO League teams at Desert Ridge:

Team 60661, Xyelodontophis Uluguruensis
Team 60662, Python
Team 62560, Robotics—Taylor's Version
Co-captain Callahan Williams led much of this effort.

The program reached approximately 20 students each week and continued for a second year.
Verus Research Engineering ReviewENIGMA welcomed engineers Jake and Aaron from Verus Research to the team's workshop.

They reviewed Link, examined the team's CAD, and discussed possible mechanical improvements with the students. Their feedback gave team members an opportunity to present their design choices to working engineers and receive an outside technical perspective.

One concept they discussed was using a winch-based climbing system. Although the team did not have enough time to implement the suggestion before competition, the conversation exposed students to another method of managing climbing loads and packaging an ascent mechanism.

The visit demonstrated an important part of the engineering process: even when a recommendation cannot be implemented immediately, professional feedback can influence future designs and expand the team's understanding of possible solutions.
Albuquerque Police Department Bomb Squad DemonstrationMembers of the Albuquerque Police Department Bomb Squad visited the robotics community and demonstrated three public-safety robots along with several drones.

One of the robots had been developed by the Bomb Squad itself, giving students an opportunity to see how real users sometimes modify or create machines for specialized operating environments.

ENIGMA students joined members of other FIRST LEGO League and FIRST Robotics Competition teams in asking questions, examining the equipment, and sharing their own robots.

The Bomb Squad members discussed how robotics, mechanical design, electronics, remote operation, and CAD are used in real public-safety work. The demonstration helped students connect the skills practiced through FTC with machines designed to perform hazardous tasks while keeping people at a safer distance.
Additional Robotics MentoringENIGMA also supported five additional robotics teams at Desert Ridge, reaching approximately 40 more students weekly.

This expanded the team's influence beyond only registered competition teams and helped create a broader pipeline of young builders and programmers.
Mentoring FTC Team 27413ENIGMA mentored rookie FTC Team 27413, SPQR Robotics.

Support included:
Technical guidance
Programming assistance
Tools
Robot parts

Workshop space
3D printing
CNC manufacturing
Troubleshooting
Competition preparation
The relationship reflected ENIGMA's belief that regional strength grows when experienced teams actively support new programs.
Hosting the Albuquerque FLL QualifierENIGMA helped host the Albuquerque FIRST LEGO League Qualifier for a second year.

The team:
Helped pay for the venue.
Provided food and drinks for volunteers.
Operated concessions.
Recruited volunteers.
Filled event roles.
Coordinated with FTC Team 23974.
Provided robot demonstrations.
Helped improve the event schedule.
The qualifier reached an estimated 600 people.
Improving Outreach Through InteractionThe team recognized that outreach is more effective when visitors can participate rather than only listen.

ENIGMA began bringing robots that children could drive. This changed demonstrations from passive presentations into memorable hands-on experiences.

Students learned that allowing a young person to control a robot can create more excitement than a lengthy explanation of what the robot does.
Alumni MentorshipSeveral ENIGMA and FIRST alumni returned as mentors.

Gray, Peter, Felix, Dave, and Morgan contributed knowledge in CAD, building, programming, outreach, and portfolio development.

Alumni mentorship gave current students access to people who understood both the technical work and the culture of the team.

It also demonstrated the long-term value of FIRST: students eventually return as the mentors they once needed.
Professional Engineering ConnectionsThe team worked with mechanical engineers Matt Williams and Isaiah Natoni.

Their feedback helped students identify robot problems, consider alternative solutions, and connect classroom concepts to professional engineering practice.
Fundraising, Merchandising, and Team IdentityStudents designed pins, jerseys, buttons, and other team materials connected to the FIRST DIVE theme.

Team leadership also developed plans for budgeting, fundraising, sponsor outreach, and maintaining relationships with prior supporters.

These efforts taught students that sustaining a robotics team requires business, communication, design, and financial planning alongside technical ability.

Spring Maker Faire

May 3, 2024 · La Academia De Esperanza Charter School · 50 reached · 6 volunteers

ENIGMA demonstrated robots at La Academia de Esperanza Charter School's Spring Maker Faire.

The event gave students an opportunity to explain FIRST programs and allow visitors to see competition robots in person.

This was the team's second year participating.

Homeschool Resource Fair

May 4, 2024 · CAPE Convention Exhibitor · 600 reached · 5 volunteers

ENIGMA demonstrated robots for homeschool students and families.

The team used hands-on robotics to show that FIRST can provide engineering, programming, teamwork, leadership, and competition opportunities outside a traditional school program.

Technology Leadership High School Networking Event

May 21, 2024 · Technology Leadership High School · 180 reached · 5 volunteers

ENIGMA participated in a networking event at Technology Leadership High School and provided a robot demonstration.

Students shared their work with educators, community members, and other young people interested in technology.

Albuquerque Isotopes Robotics Exposition

Albuquerque Isotopes - Ball Park · 6700 reached · 12 volunteers

ENIGMA joined FRC Teams 4153, 6974, and 9080, along with FTC Teams 10348 and 20334, for a FIRST robotics exposition at an Albuquerque Isotopes baseball game.

The participating teams demonstrated multiple levels of FIRST and showed visitors how students can progress from introductory robotics through FTC and FRC.

An Isotopes game can draw more than 6,700 people, giving the exposition one of the season's largest potential audiences.

Manzano High School Open House

Aug 22, 2024 · Manzano High School - Teen Tech Center · 200 reached · 14 volunteers

ENIGMA and FRC Team 8512 represented FIRST Robotics at Manzano High School's open house.

The teams introduced students and families to robotics and encouraged new participation.

The event reached an estimated 200 people.

Panera and Xfinity Outreach

Sep 30, 2024 · Panera Bread · 75 reached · 12 volunteers

The team participated in a Panera fundraising event and presented its design work, CAD, and previous robot Mantis to representatives connected with the local Xfinity office.

These interactions combined fundraising, technical presentation, and professional networking.

Hosting the Albuquerque FLL Qualifier

God's House Church 2335 Wyoming Blvd NE, Albuquerque, NM 87112 · 300 reached · 24 volunteers

ENIGMA helped host the Albuquerque FIRST LEGO League Qualifier for a second year.

The team:
Helped pay for the venue.
Provided food and drinks for volunteers.
Operated concessions.
Recruited volunteers.
Filled event roles.
Coordinated with FTC Team 23974.
Provided robot demonstrations.
Helped improve the event schedule.
The qualifier reached an estimated 600 people.

Albuquerque Police Department Bomb Squad Demonstration

Desert Ridge Middle School · 120 reached · 6 volunteers

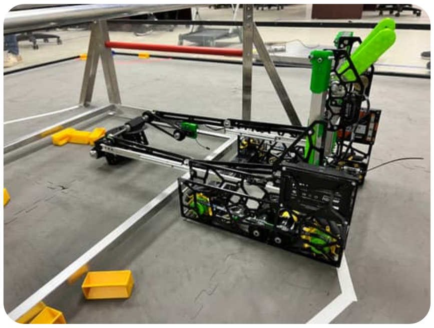
Members of the Albuquerque Police Department Bomb Squad visited the robotics community and demonstrated three public-safety robots along with several drones.

One of the robots had been developed by the Bomb Squad itself, giving students an opportunity to see how real users sometimes modify or create machines for specialized operating environments.

ENIGMA students joined members of other FIRST LEGO League and FIRST Robotics Competition teams in asking questions, examining the equipment, and sharing their own robots.

The Bomb Squad members discussed how robotics, mechanical design, electronics, remote operation, and CAD are used in real public-safety work. The demonstration helped students connect the skills practiced through FTC with machines designed to perform hazardous tasks while keeping people at a safer distance.

Season highlights



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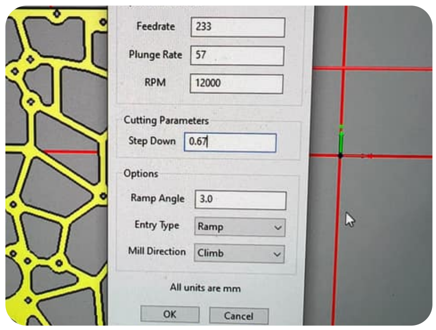

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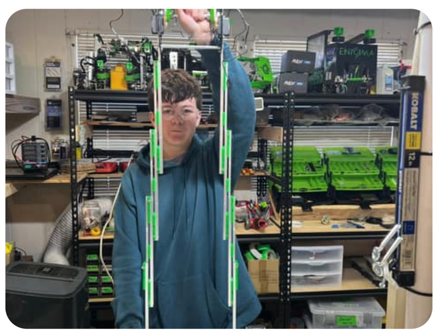

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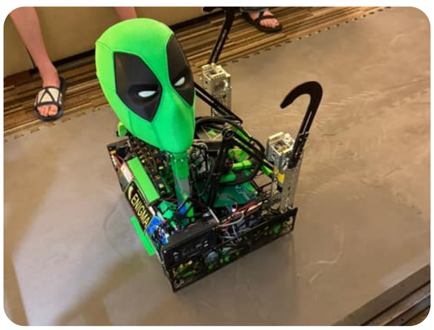
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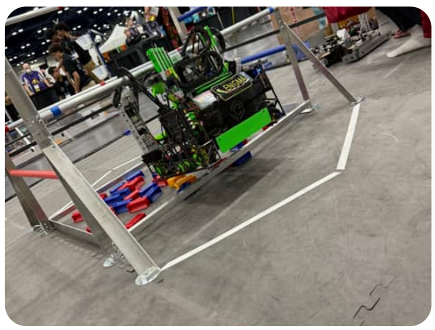
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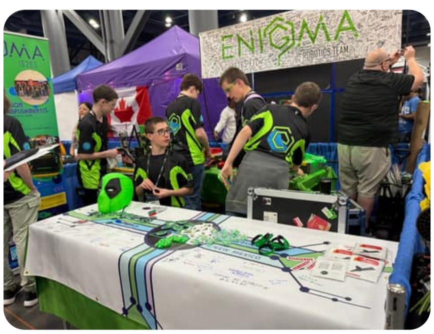

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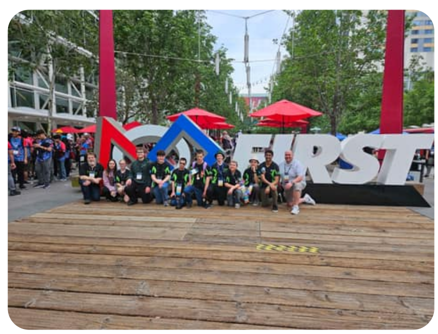

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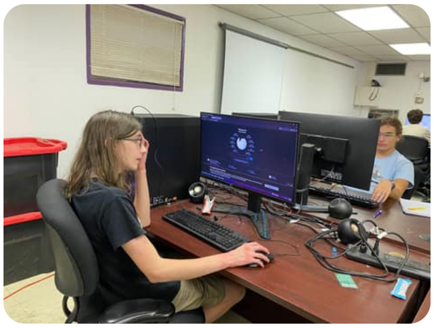
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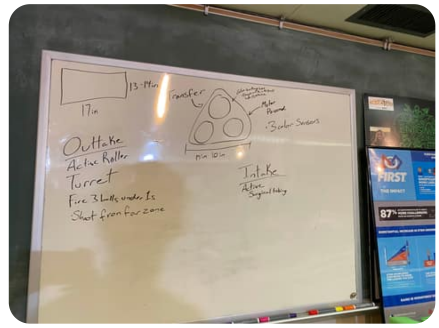
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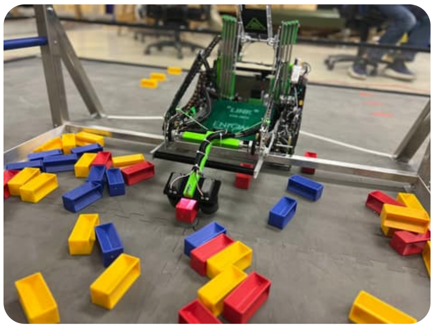
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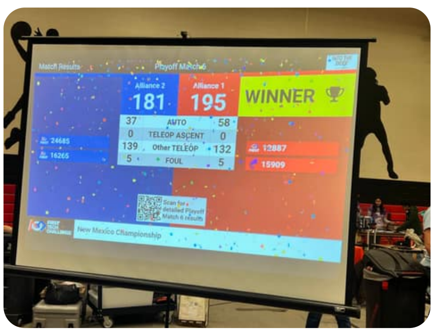

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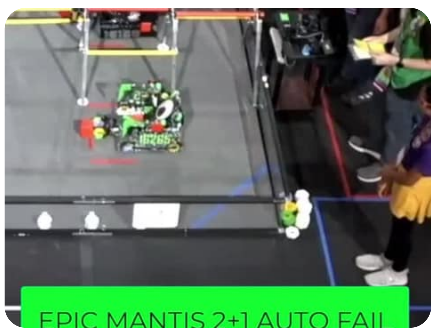

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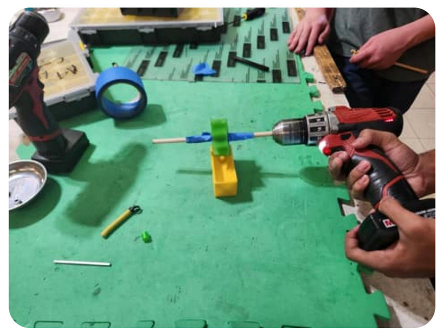
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