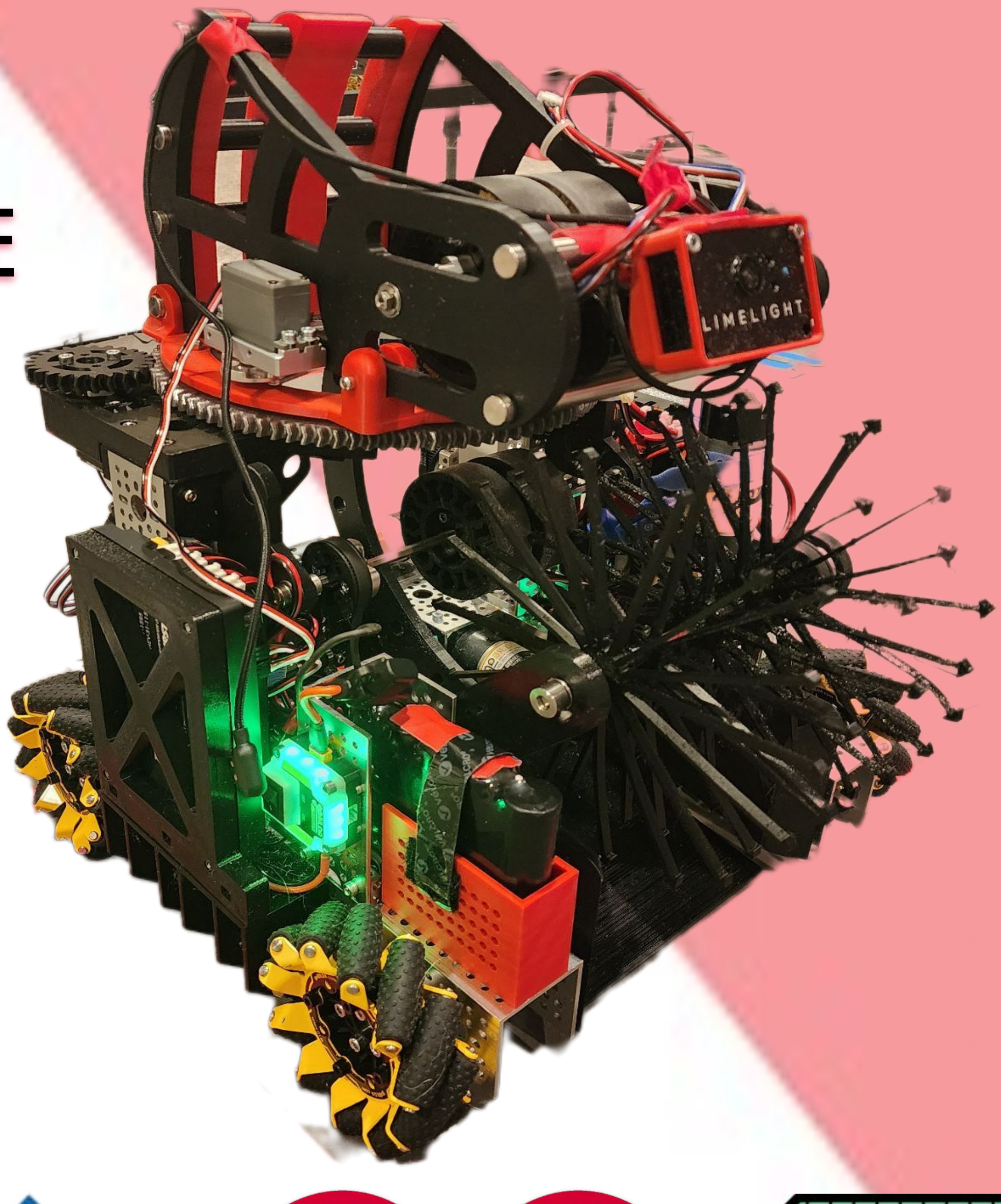
INFINITY TECH #13684

2025-2026 Decode

Ball-E



East Middle School
Plymouth Canton Community Schools

Infinity Tech Robotics — Team #13684

15 Team Members	4 Sixth Graders	8 Seventh Graders	3 Eighth Graders	4 Lead Mentors

Our mission: **"To create an infinite stream of technologists"**

ESTABLISHED IN 2017

We are Infinity Tech, FTC Team 13684. We were founded by a group of middle schoolers from East Middle School in Plymouth Canton. 2025 is our 9th Season!

Decode Season Goals

Achieved

- ✅ Raise $7,300 or more
  - Sponsors, fundraising
- ✅ Implement Learning Plan
  - Courses, design challenge
- ✅ Collect More Robot Data
- ✅ Develop Innovative Mech
  - Auto Aim Turret, Spintake
- ✅ Recruit 5 new team members
- ✅ Identify 5 new mentors
- ✅ Host or Volunteer at 5 events
  - Kickoff, RitP, Roundup, etc.

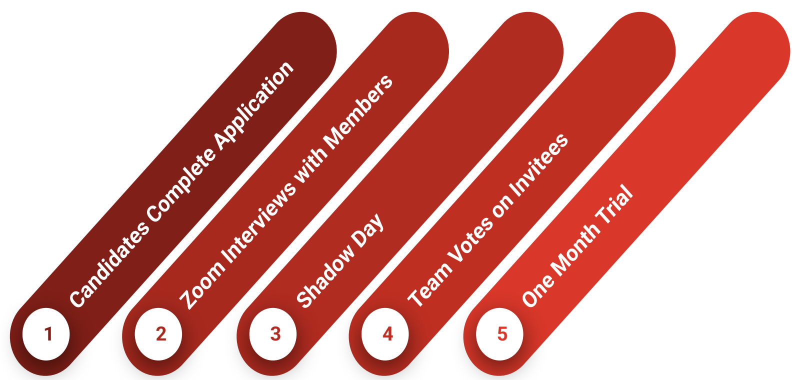
In Progress

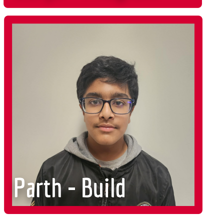
- 🟨 Develop Distinct Brand
  - robot styling, colors, design
- 🟨 Sensors for More Reliability
  - Limelight, RPM encoder
- 🟨 500 hours of Outreach
- 🟨 5 Field Trips (4 so far)
- 🟨 Track Issues with Robot
  - Build & Programming

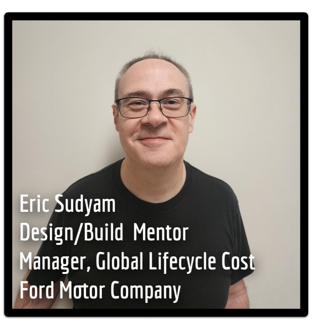
Recruiting New Team Members

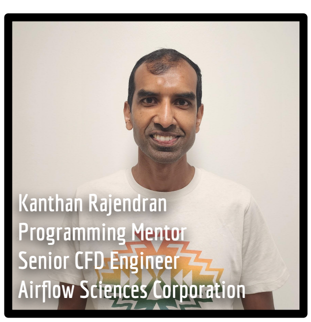
Infinity Tech's uses a student-led recruitment process. We seek:

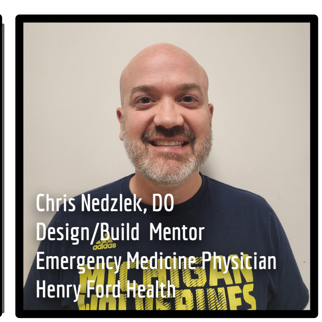
- Minimum 3 students per grade for sustainability
- Parents who can mentor for sustainability
- Prior FLL experience to show interest and commitment
- Good attitude and graciousness for team dynamics

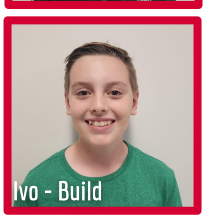


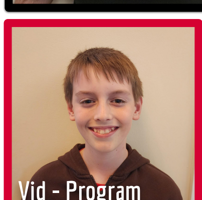


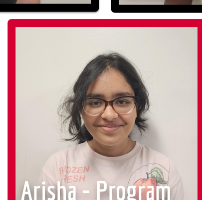


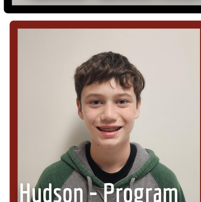


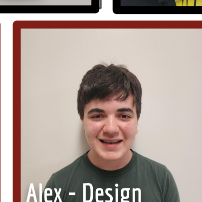


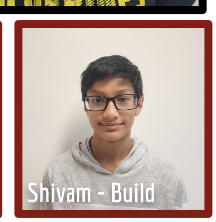




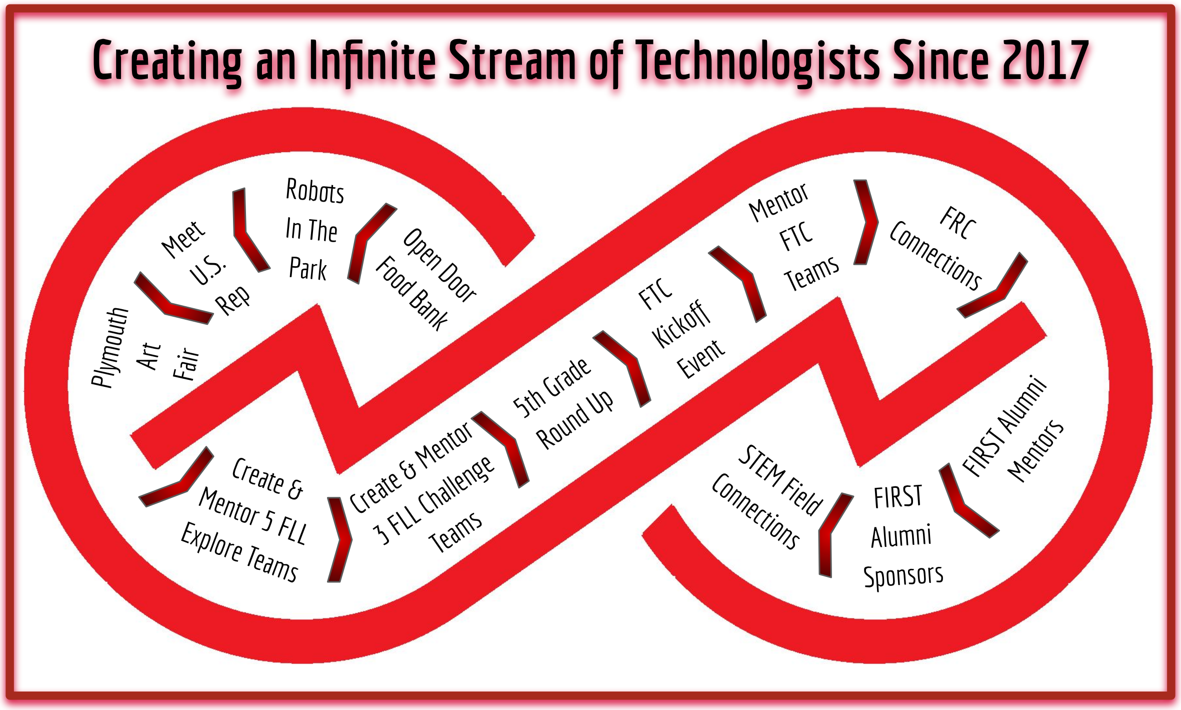




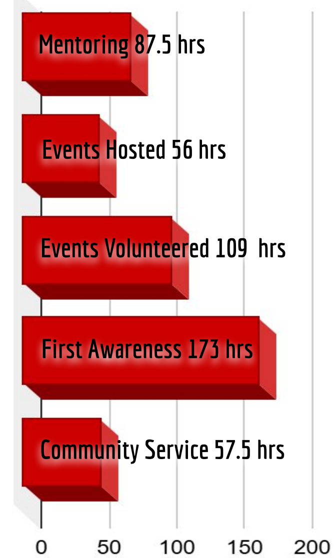




OUTREACH Impact



483 Total Outreach Hours



4661 Total People Reached

Our Outreach Impact

In addition to our core robotics work, Infinity Tech is determined to make an impact in our community. After the Covid-19 pandemic, we were one of 2 teams left out of 12 FTC teams that had previously represented the Plymouth-Canton community. As a veteran team, we decided to help start up new robotics teams in our district to introduce more kids to these STEAM opportunities. Between 2022 and 2025, we started and continue to mentor 5 new FTC Challenge teams, 3 FLL Challenge teams and 5 FLL Explore teams. We brought FLL into elementary schools that previously did not have a robotics program. We are proud to have helped bring our community to 14 FTC teams. We are always in the process of starting even more teams for future seasons. The outreach we do allows the Plymouth-Canton school district to thrive in robotics, giving kids the skills they need going forward. We exceeded our goal this year to reach 360 hours community service with 483 hours served. We are so pleased to have connected with 4,661 people in our community.

FIRST Team Partnerships

FIRST LEGO LEAGUE EXPLORE — KINDERGARTEN - GRADE 3

5 FLL Explore Teams
Dodson Elementary

FIRST LEGO LEAGUE CHALLENGE — UPPER ELEMENTARY

3 FLL Challenge Teams
Dodson Elementary & Gallimore Elementary

FIRST TECH CHALLENGE — MIDDLE SCHOOL

4 FTC Challenge Teams
East Middle School & Liberty Middle School

FIRST ROBOTICS COMPETITION — HIGH SCHOOL

1 FRC Team
Team Members Graduate into our 862 Lightning Robotics Partner

OUTREACH | Reach

Our Infinite Loop Begins with Reaching the General Community

Open Door Ministries Food Pantry

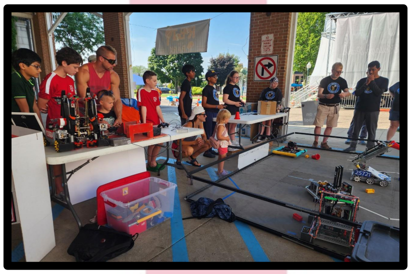
We volunteered at our local food bank several times, sorting and filling carts with food for local families. We helped **730 families** (approximately 2920 people) and moved 56,733 pounds of food.

U.S. Representative Debbie Dingell

At the August Robots in the Park event, our FTC team hosted a booth and met with U.S. Representative Debbie Dingell (MI-6). She praised our team's volunteer efforts in promoting robotics. We discussed with her the importance of maintaining or increasing funding for robotics and STEM education. We also conducted letter-writing campaigns and sent emails to all government representatives during budget reviews.

Plymouth Art In the Park

Infinity Tech fundraised at Art in the Park, Michigan's 2nd largest art fair (300,000+ attendees). Team members designed and 3D-printed fidget toys, selling **480 items** for $2,303 (net income: $1,823.91). Over three days, we directly **engaged 1,230 people**, showcasing our robot and promoting FIRST programs. This initiative successfully raised funds and promoted FIRST.



Robots in the Park

A free day-long event by Lightning Robotics FRC 862, offers STEM activities for all ages, including physics, electrical, chemical, and aeronautical projects. Demonstrations highlight Plymouth Canton community robotics programs. Infinity Tech hosted the FTC section, where participants drove robots to earn a Robot Drivers License and activity stamp. We directly **interacted with 1,500** kids and adults.

STEM Sessions and Merit Badges

We have partnered with our local **Girl Scout Troop 40118** of Hulsing Elementary School and are excited to hold future robot coding session for them to earn a robotics STEM merit badge.

girl scouts

Type of Service	Hours	# People Reached
Mentoring	87.5	457
Events hosted	56	305
Events volunteer	109	1256
Creating FIRST awareness	173	1256
Community Service	57.5	1083
Total	**483**	**4661**

Summary of Outreach	Team Hours	# People Reached
FLL Explore	62.5	418
FLL Challenge	19.5	34
FTC Mentoring	20.5	83
5th Grade Round Up	32	100
Food Bank	57.5	1083
CAD Online Sessions	9	27
IGVC	3	22
Amazon	12	2
Plymouth Art Fair	123	1230
U of M Tours	35	2
Robots In The Park	85	1500
Kickoff Event	24	160
Total	**483**	**4661**

The Second Part of Our Infinite Loop Is Fostering FIRST Programs from FLL to FTC to FRC

FLL Explore Mentoring

Infinity Tech organized and mentored **five FLL Explore teams** (30 students, 1st-3rd grade) at Dodson Elementary over 12 weeks from March-May. We taught block programming, building, and prepared them for their Expo. We also showcased our "Mr. Mussel" robot and a practice chassis, aiming to deepen their understanding and excitement for robotics.

FLL Challenge Mentoring

Infinity Tech founded (2024) and currently mentors Dodson Elementary's FLL Challenge team #65886. We also mentored Gallimore Elementary teams #34357 and #34355, which reached a Florida Invitational. We donated our old FLL game board to Dodson and provided "Elvis" Spike Prime robot base instructions. We assist teams with robot building, programming, Innovation Projects, and share our FLL experience.

5th Grade Robotics Round Up

Infinity Tech and Lightning Robotics (FRC #862) host an annual 5th Grade Robotics Round Up in March for prospective FTC team members. This year, **40 students** attended. We demonstrated our robots and explained the FTC program to parents, contributing to the formation of more teams in the district.

FTC Kickoff

Infinity Tech and Lightning Robotics hosted an official FTC Kickoff at Canton High School. **Over 180 people from 15 teams attended**, gaining general competition information and participating in popular build, design, programming, and business breakout sessions: six hours of mentoring were led by Infinity Tech mentors. The event concluded with the live Decode competition reveal.

FTC Mentoring

Over four years, we **started 4 FTC teams** and **mentored 4 others**. We assisted with prototyping, robot building, presentation feedback, and programming. We provided weekly support and parts to Liberty Bees #25721 and Bionic Beans #27693. We also hold info and educational Zoom sessions & answer questions. We also scrimmage with Rocket Robotics #21615 and Robo Challengers #21482.

Young FIRST Alumni Mentorship

Our sustainability culture is evident with high school & college students, who are recent FIRST or FTC alumni, help mentor our team in many aspects. Several are Infinity Tech Robotics alumni, providing crucial support and serving as role models.

Young FIRST Alumni Mentors	FIRST Experience & Current Status	Sustainability Role
Adam Ong	FTC, FRC, Biomed. Engin. College Student	Design Mentorship
Karthik Rajendran	FLL, FTC, FRC, High School Sophomore	Programming Mentorship, Drive Team Selection
Adithya Srivathsa	FTC, FRC, High School Junior	General Mentorship, Drive Team Selection
Edison Thai	FLL, FTC, FRC, High School Freshman	General Mentorship, Strategy
Kai Courson	FRC, High School Senior	Presentation Mentorship
Annabelle Thai	FTC, FRC, High School Junior	Presentation Mentorship
Evan Ong	FTC, FRC, Veterinary Med College Student	Presentation, Design Mentorship

OUTREACH Connect

The Third Part of Our Infinite Loop Is Making Connections with the STEM Community

FRC Connections
Infinity Tech Robotics FTC team #13684 and Lighting Robotics FRC team #862 collaborate on events like 5th Grade Round Up, Robots in the Park and the FTC Kickoff. Our team members are prepared for FRC, and alumni frequently assist with tasks like Drive Team Selection.

Amazon Warehouse
We toured Amazon's DT3 Distribution Center in Pontiac, MI, observing autonomous technology like the 3000 lb-lifting Hercules robot, the container-sorting Roxanne robot arm, and sensor-driven conveyance tracks for automatic box sorting.

The U of M Wilson Center
This houses university student competition teams building vehicles like submarines, planes, boats, and race cars for global competitions. The director toured us through the facility, showcasing past builds like the Baja SAE dune buggy. He advised using a Gantt chart with "slop" for better season organization.

U of M Robotics Center
We learned about the University of Michigan's newer Robotics programs, observing students working on projects. A professor showcased walking robot prototypes, a sensor-laden car, a drone room with high-speed cameras and many various sensors.

IGVC - International Ground Vehicle Competition
We attended the 32nd annual International Ground Vehicle Competition at Oakland University, with teams around the world. They built autonomous ground robotic vehicles using sensors like cameras, LIDAR, and GPS. We met FIRST alumni college students from Oklahoma University.

Roblox Innovation Studio Director
Chiwei Lee, Director of Roblox Innovation Studio, shared engineering design, AI use, and drawing and branding techniques with our team. We practiced drawing perspectives and learned how styles influence design perception during branding.

Additional Connect Mentors	Organization/Position	Connect Role
Tom Golub	Detroit Diesel, Legislative Diagnostics	Programming/Build Assistance
Ed Thai	Hyundai, Senior Regulatory Safety Engineer	Design & Build Mentorship
Jay Obsniuk	Plymouth-Canton Community Schools	General Help, Tools, Meeting Space
Jennifer Rajendran	Ford, Inventory Control Manager	Team Operations
Joaquin Gabaldon, Ph.D	Wheel.Me, Robotics Engineer	Motor Behavior review
Meghna Menon	Ford, Robotics Research Engineer	Engineering review
Ka Chai Cheok, Ph.D	Oakland University, Professor, Chairman	Mechatronics review
Christabel Sin	Ford, Business Analyst	Engineering review
Marcus Ong	University of Michigan, Web App Developer	Engineering review
KaiQiao Tian, Ph.D	Oakland University, Ford, Auton & Sensor Engineer	Engineering review
Steve Derry	Ringside Creative, Graphic Designer, Data Specialist	Presentation review

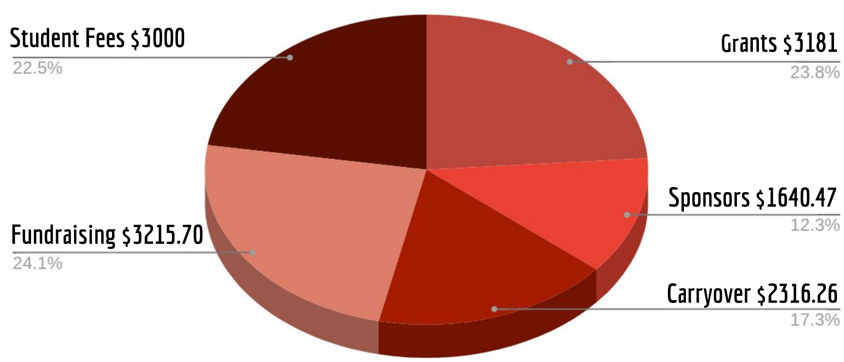
BUSINESS — Income & Expenses

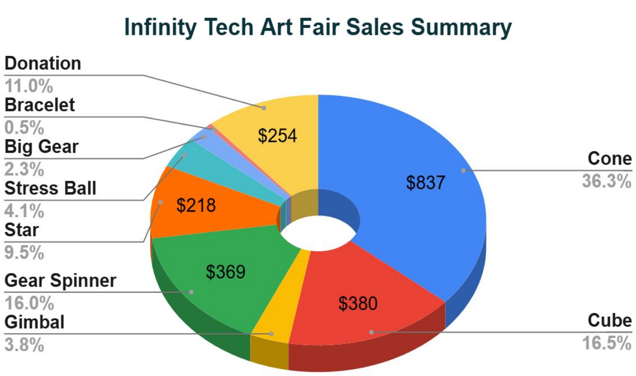
Our Expenses

We base projected expenses on prior year's needs and experiences. We met these expenses with a combination of grants, student fees, and sponsors. The funds help us pay fees, buy robot materials, and run team operations. We are fortunate that our income exceeds expenses so we plan on investing into more outreach for the coming year.

Our Team Expenses	Projected	Actual
Fees and Registration - FIRST Registration and competition Fees	$800	$325
Robot Parts and Materials - Motors, sensors, field pieces, metal extrusions, controllers, Android devices, etc.	$4000	$4863.51
Team Operations - T-shirts, food at events, merchandise	$1500	$1177.51
Outreach - Workshops, outreach events	$1000	$508.80
TOTAL EXPENSES	**$7300**	**$6874.82**

Total 2025 Income $13,353.50





In addition to grants and sponsorships, we raised money for our team by selling 3D printed fidget toys at the Plymouth Art Fair. We sold 480 fidget toys for a total of $2,303, which really helped us in buying robot parts when the season got underway.

Grants

- $2000 Gene Haas Foundation
- $350 AutoDesk
- $875 Michigan Department of Education

Sponsorships

- $500 KACC Inc
- $400 RectechX
- $500 Bank of Ann Arbor
- $250 Twinkle Twinkle Little Store
- $100 Brand-It

Fundraising

- $2,303 Plymouth Art Fair
- $333 Can and Bottle Drive
- $499.50 Clothing Drive with Twinkle Twinkle Little Store

Team Member Dues

- $200 each for the season, for a total of $3000

Carryover from Last Season

- $2,316.26 from the prior year.

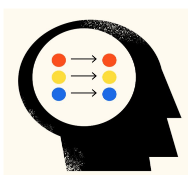
Business Team Liaisons

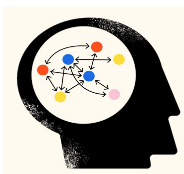
Historically, members joined for robotics, not business, challenging team formation. Last year's independent business subgroup caused workload and information issues. This year, we've integrated business liaisons from our Design, Build & Programming teams. All members now have secondary business and strategy roles and attend separate meetings.

Primary Roles

Design	Build	Program	Business
Davis Frances Ramanan Rishaan	Alex Avni Ivo Luke Parth Shivam	Arisha Hudson Isha Surya Vid	Avni Davis Hudson Luke Parth

Linear Thinking





Systems Thinking

Secondary Roles

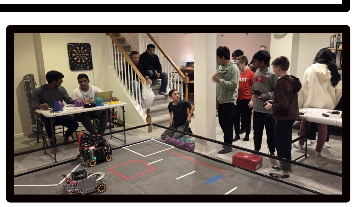
Role	Members
Strategy / Scouting	Arisha, Ivo, Frances
Rules Expert	Surya, Isha
Accounts / Budget	Avni
Issues - Build	Alex, Rishaan
Issues - Coding	Vid
Awards	Hudson
Schedule / Inventory	Alex
Team Identity/Brand	Davis, Parth
Portfolio Committee	Luke, Ramanan, Shivam, Surya

An Overview of Our 4 Seasons:

SPRING SEASON JAN to MAY	SUMMER SEASON JUNE to AUG	BUILD SEASON SEPT to OCT	COMPETITION NOV to DEC
Prior Season Recap Recruit & Interview New Team Members Outreach Mentor FLL Explore teams Learn New Skills Outreach Off Season Challenge Meet once per week	Outreach Prepare for New Season - Engineering Design Course JAVA Online Course CAD Online Course Build Chassis Field Trips Determine team member roles Meet once per week	FTC Kickoff Event for Game Release Design, Build and Program In Action Engineering Portfolio Meet 3-7 times a week Continued Fundraising Mentor FTC teams & FLL Challenge Teams	Participate in Qualifiers Iterate / Improve Robot Improve Portfolio Compete at States?!? Meet 5-7 times a week Drive Team Practice

Drive Team Selection Process

Unlike FLL, not everyone gets a chance to operate the robot at competitions. We have our team's alumni students come back and help with the selection process to help make it unbiased. We need a good drive team for our competition, but how do select them? We test for game knowledge, reaction time, and performance.



Drive Team Trial Process

Team members pick their 2 preferred drive team roles, then:

DESIGN

Development & SPIRE

OpenLearn | Free learning from The Open University

Statement of participation

Hudson Fish

An introduction to design engineering

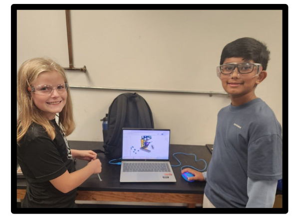
Issue date: 18 May 2025

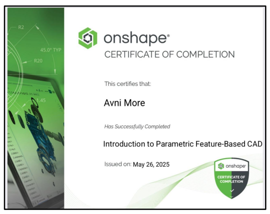
Engineering Design Course on OpenLearn

To foster creativity, our 15-member team completed a free online OpenLearn engineering design course during the spring off-season, finishing one section weekly. All members received participation statements.

Design Challenges - Fusion 360 & OnShape CAD Programs

We used Fusion 360 for many of our CAD projects. But collaboration is difficult on software that is limited in users per license and must be downloaded to specific computers that were robust enough to handle the software. We decided to also use OnShape, a cloud based CAD program, with unlimited users to expand our ability to collaborate with the whole team.





onshape

CERTIFICATE OF COMPLETION

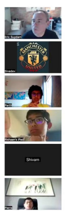
This certifies that

Avni More

Has Successfully Completed

Introduction to Parametric Feature-Based CAD

Issued on: May 26, 2025



OnShape CAD Programs & Zoom Lessons

We adopted Onshape, a new CAD software. To overcome the learning curve, we hosted weekly online CAD design classes during the offseason, inviting students from other FTC teams. Three external teams participated. We also completed Onshape tutorials and earned certificates.

FRC Inspiration

We started by analyzing prior challenges and identified parallels to the FRC Steamworks season. Our design drew inspiration from our high school teams world champion robot, Valkyrie.

Branding

During the pre-season, we set goals to incorporate more 3D-printed components and to develop a consistent color scheme to strengthen our robots branding. We met with a Roblox Innovation Studio Director to learn about brand identity and applied those principles throughout our design process this season

During the season, our build team follows a process called “S.P.I.R.E.” developed in our team’s prior years. Using our version of the Engineering Process, which consists of 5 steps, we turn the idea into a reality. Below is an example of this process, more examples can be found at our pit.

Sketch	Prototype	Innovate	Revise	Embellish
Our first step towards a physical piece starts with getting our ideas **represented through a rough sketch**. During this phase, **markers and pencils are our medium.**	Next we do our best to turn this **sketch into a physical concept,** which helps us decide if we want to use this design. During this phase, materials like **cardboard and plastic are our medium.**	Now knowing this concept works, we design it in CAD, with the intention to **customize the part** to fit our needs more exactly. During this phase, **CAD such as OnShape serves as our medium.**	Once we have a rough idea/design, we put the concept through different situations and tests, going through multiple iterations, and **optimizing the design.** During this phase, we use a variety of materials.	After reaching our optimized state, we improve attributes such as **sleekness and aesthetic design,** to make the part competition ready. The design has gone from an idea to a reality, **ready for competition day.**

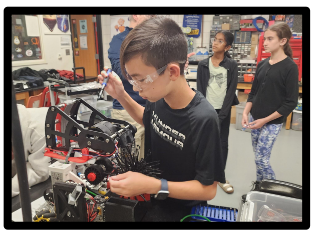
"You get what you WORK for, not what you WISH for"

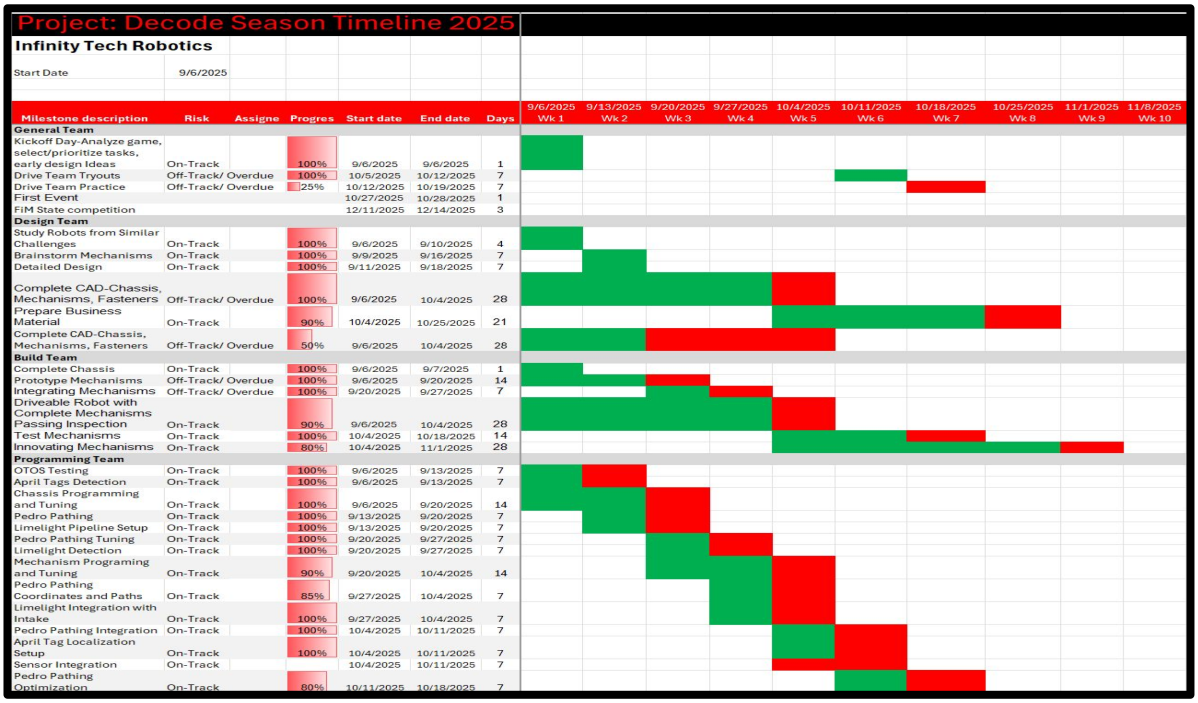
Preseason Preparation & Goals:

Managing workload & time is a challenge. In prior years, there were product shortages. To avoid prior out-of-stock issues, parts were ordered early summer. Chassis construction began in July for both our competition robot and our "Lab Rat" testing robot. The team opted for a smaller 16"x16" chassis which proved very advantageous for this year's end game, and aimed for a lighter robot for smoother movement. The 2024 Cybugs chassis inspired us to package our more compact drivetrain.

GANTT Chart to Keep Timelines

Our limited time is always a great challenge. We made a list of tasks set timeline goals for when we should be working on each task & when it is our goal to complete it.





Project: Decode Season Timeline 2025

Infinity Tech Robotics

Start Date 9/6/2025

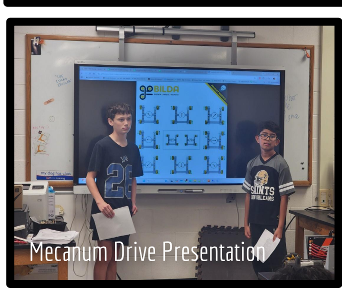
Milestone description	Risk	Assigne	Progres	Start date	End date	Days
General Team						
Kickoff Day-Analyze game, select/prioritize tasks, early design Ideas	On-Track		100%	9/6/2025	9/6/2025	1
Drive Team Tryouts	Off-Track/ Overdue		100%	10/5/2025	10/12/2025	7
Drive Team Practice	Off-Track/ Overdue		25%	10/12/2025	10/19/2025	7
First Event				10/27/2025	10/28/2025	1
FiM State competition				12/11/2025	12/14/2025	3
Design Team						
Study Robots from Similar Challenges	On-Track		100%	9/6/2025	9/10/2025	4
Brainstorm Mechanisms	On-Track		100%	9/9/2025	9/16/2025	7
Detailed Design	On-Track		100%	9/11/2025	9/18/2025	7
Complete CAD-Chassis, Mechanisms, Fasteners	Off-Track/ Overdue		100%	9/6/2025	10/4/2025	28
Prepare Business Material	On-Track		90%	10/4/2025	10/25/2025	21
Complete CAD-Chassis, Mechanisms, Fasteners	Off-Track/ Overdue		50%	9/6/2025	10/4/2025	28
Build Team						
Complete Chassis	On-Track		100%	9/6/2025	9/7/2025	1
Prototype Mechanisms	Off-Track/ Overdue		100%	9/6/2025	9/20/2025	14
Integrating Mechanisms	Off-Track/ Overdue		100%	9/20/2025	9/27/2025	7
Driveable Robot with Complete Mechanisms Passing Inspection	On-Track		90%	9/6/2025	10/4/2025	28
Test Mechanisms	On-Track		100%	10/4/2025	10/18/2025	14
Innovating Mechanisms	On-Track		80%	10/4/2025	11/1/2025	28
Programming Team						
OTOS Testing	On-Track		100%	9/6/2025	9/13/2025	7
April Tags Detection	On-Track		100%	9/6/2025	9/13/2025	7
Chassis Programming and Tuning	On-Track		100%	9/6/2025	9/20/2025	14
Pedro Pathing	On-Track		100%	9/13/2025	9/20/2025	7
Limelight Pipeline Setup	On-Track		100%	9/13/2025	9/20/2025	7
Pedro Pathing Tuning	On-Track		100%	9/20/2025	9/27/2025	7
Limelight Detection	On-Track		100%	9/20/2025	9/27/2025	7
Mechanism Programing and Tuning	On-Track		90%	9/20/2025	10/4/2025	14
Pedro Pathing Coordinates and Paths	On-Track		85%	9/27/2025	10/4/2025	7
Limelight Integration with Intake	On-Track		100%	9/27/2025	10/4/2025	7
Pedro Pathing Integration	On-Track		100%	10/4/2025	10/11/2025	7
April Tag Localization Setup	On-Track		100%	10/4/2025	10/11/2025	7
Sensor Integration	On-Track			10/4/2025	10/11/2025	7
Pedro Pathing Optimization	On-Track		80%	10/11/2025	10/18/2025	7

Pre Season Competition Challenge

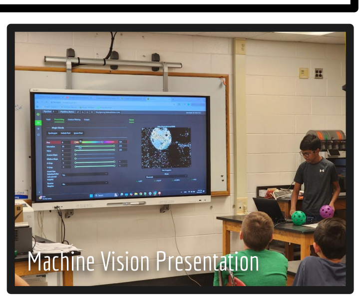
To help us practice and expand our knowledge, we divided our team into 3 groups and created our own different robots with the goal of moving various game pieces from prior year competitions. It helped us research and learn about the capabilities and limitations of our robot.

Subject Matter Experts

To deepen team knowledge, members became Subject Matter Experts on various topics, researching them over the summer. Weekly 5-minute presentations by a different student educated the entire team.



Mecanum Drive Presentation



Machine Vision Presentation

Kanban Board for Tasks and Progress Tracking

We used a Kanban board to note tasks in To Do, In Progress, Testing and Done status. This was helpful if there were team members that needed to know what to work on next.

PROGRAMMING Challenges & Solutions

Online Java Course codecademy

It is a huge leap to go from SPIKE block coding in 5th grade to coding in Java, so to help accomplish this challenge, all team members did an online Java programming course on Codecademy over the summer. Existing programming team members got to improve their skills. Our new 6th grader team members got their first introduction to non-block coding. Non-programming team members got insight into what programming is like.

On Bot Java

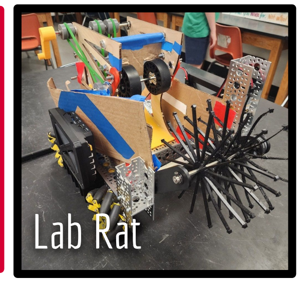
Before we started coding on Android Studio, all programming members started the season with On Bot Java. This easy to navigate interface helped us to learn more coding, while also getting experience coding the robot.

Android Studio and GitHub

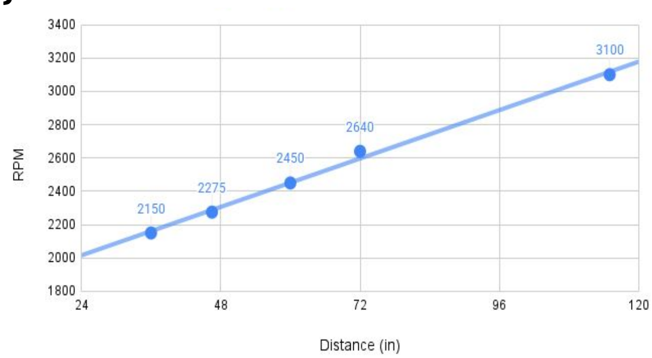
During our 2024-2025 Into The Deep season, all of the programmers on the team used Android Studios, but we couldn't directly collaborate with each other. Instead, we had to email each other code back and forth so that we could revise and edit the program, and then email the edited code back. For the Decode season, we stored our code on Github, an online repository. All programmers set up Github accounts so we could work on the code at the same time and improve teamwork and collaboration. This allowed us to make progress a lot quicker and faster. We have over 125 commits, or update milestones, to our repository so far this season.

Duplicate Practice Chassis - "Lab Rat"

During the build season, it is often a challenge when the design, build and programming teams all want to work on the robot at the same time. In order to help alleviate this problem, during the summer off season, we built a duplicate chassis with the same motors, dimensions and wheels. This allows our programming team to be able to work on programming while the design and build team can work on the competition chassis. This is great due to our limited meeting time available.



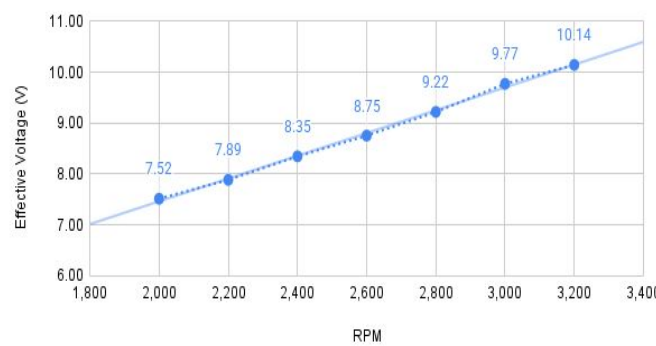
Flywheel RPM vs Distance to Goal



After we came up with our flywheel shooter concept, we realized fairly quickly that the distance the artifact travelled depended on the RPM (rotations per minute) of the flywheel. To understand this, we collected data on what RPM was needed to score artifacts from different distances. Graphing the data using Google Sheets, we came up with the following relationship:

```
flywheelRPM = (12.1 * Distance) + 1275
```

Effective Voltage vs Flywheel RPM

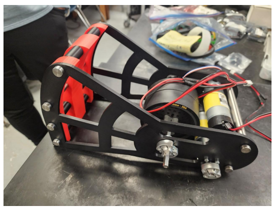


The next challenge was obtaining the needed flywheel RPM. We observed that a freshly charged battery shot Artifacts farther than an old battery with the same motor power setting. We concluded that we had to account for the current battery status and collected data on effective voltage vs flywheel RPM.

```
effectiveVoltage = 0.00224*RPM + 2.99
motorPower = effectiveVolt / batteryVolt
```

Auto Targeting and Ranging Shooter

We set out to create an accurate and consistent shooter for our robot since the main point potential in the Decode game is through scoring Artifacts. After we came up with our flywheel shooter prototype, we started testing it and collected data on RPM vs range and battery voltage vs RPM. We graphed the data and came up with equations that we then incorporated into our code. Using the bearing and range data that we obtain from the Limelight 3A camera, we are able to automatically aim our shooter to the goal using the rotating turret. We also set the flywheel RPM based on the distance to goal and battery voltage using the control sequence shown below. This control system removed guesswork when it comes to shooting from different locations on the field.



Auto Targeting and Ranging Shooter

Limelight 3A to Detect AprilTag

AprilTag ID → ID 20 (Blue Alliance) / ID 24 (Red Alliance)

tx = Bearing

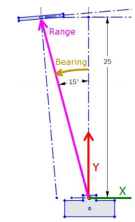
Turret Aiming

```
error = bearing;
newServoPos = currentServoPos
    + error * 0.0004;
```

Rotate Turret to Aim

Bearing is the horizontal angle between camera and AprilTag.

We use a proportional controller based on the bearing to update turret servo position to align our shooter.

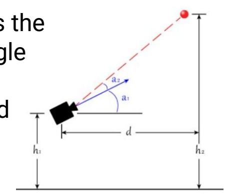


ty = Elevation

Range Calculation

```
distanceToGoalInches = (h2 - h1) /
    Math.tan(angleToGoalRadians);
```

Elevation is the vertical angle between camera and AprilTag.

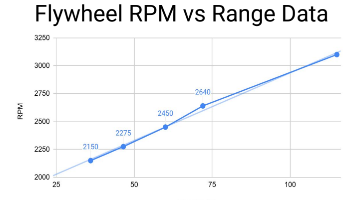


goBILDA 6000 RPM Motor

Motor RPM Calculation

```
flywheelRPM = (deltaTicks / CPR)
    / (deltaTime / 60);
```

Flywheel RPM vs Range Data

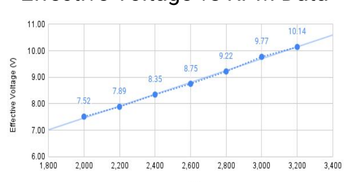


Target RPM

We account for differences in battery voltage (charged vs discharged) to achieve target RPM.

REV 12V Battery

Effective Voltage vs RPM Data



Target Effective Voltage

Motor Power Calculation

```
flywheelPower = targetVoltage /
    currentbatteryVoltage;
```

Set Flywheel Power

Code Structure

We are working to organize our code for each of our subsystems or mechanisms into individual classes with functions for every behavior we need. Then the main class integrates the functions in the different classes so it could be used in all our OpModes.

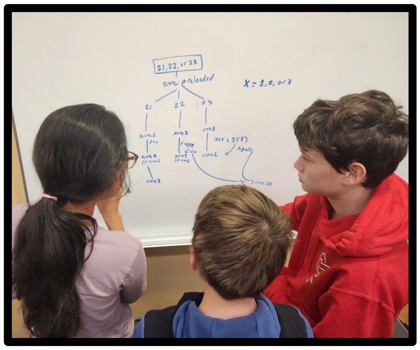
Ball-E: Limelight, Drive, Intake, Pinpoint, Transfer, PedroPathing, Shooter

Software Assistance in Autonomous - Limelight

We use limelight in Auton for april tag detection. During our first step, we have a code set up for it to detect the Motif april tags, which have ID's of 21, 22, or 23. Once we have detected one of those, we chose where our code goes from there. For example, if it's ID 22, we pick up the artifacts in the middle spike mark.

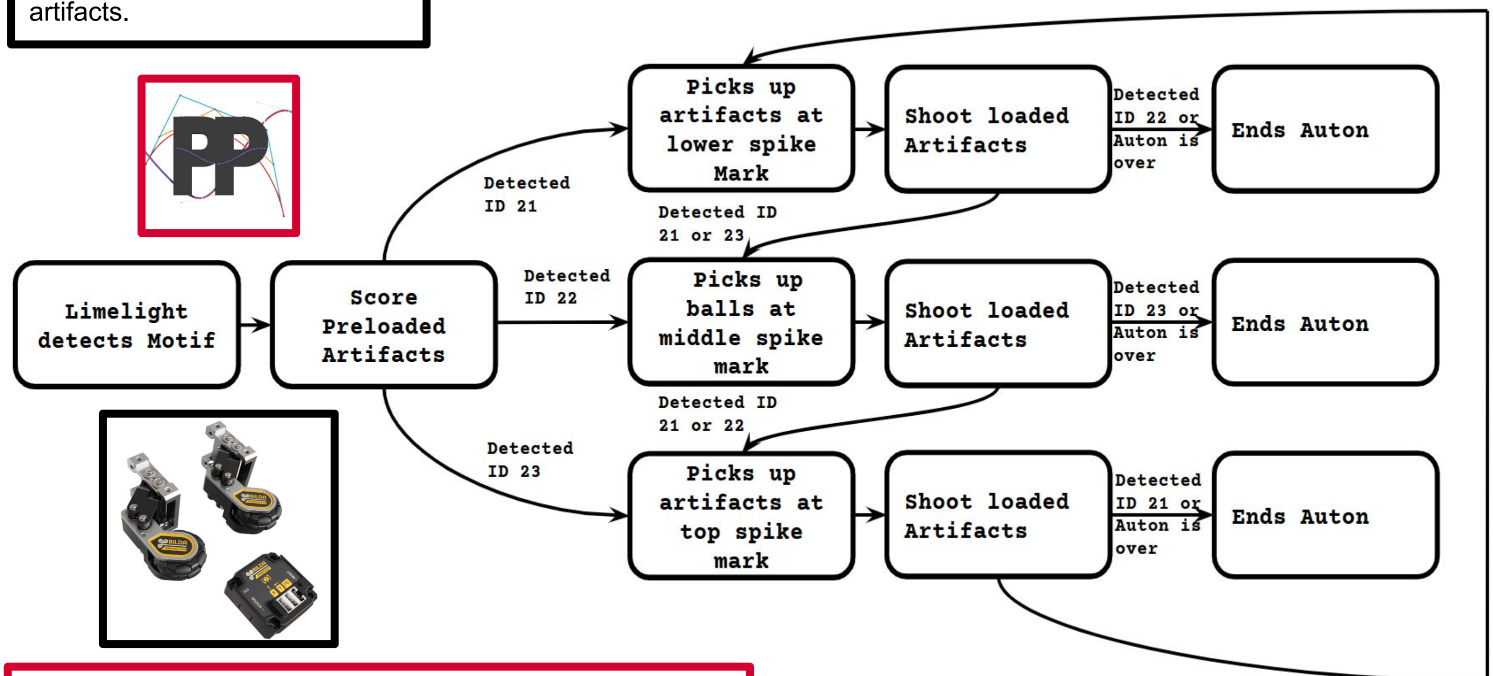
Auton Flow Chart

In our code, we first shoot our three preloaded artifacts, then based off of which motif was selected for the match, we go to the spike mark position for the motif, pick up the artifacts, and shoot them. Then we do the same for the remaining sets of artifacts.



Software Assistance in Autonomous - PedroPathing

Last year, our team tried a new path planning tool for auton called PedroPathing. In the code, we define locations on the field called poses, and by combining poses we make paths which the robot can follow. Then we use a switch-case-construct to add timers and actions, which fully builds the auton. PedroPathing makes paths that include Bezier curves, which are the optimal method of travel between locations on the field. We received much more consistent results with PedroPathing and proved to be more effective.



PinPoint + 4 Bar Odometry

The goBILDA Pinpoint is an odometry computer that computes odometry data without putting strain on the Control Hub, and comes with its own IMU. It also connects to two precise odometry pods, specialized for the Pinpoint system. The Pinpoint has proven to have less drift than other odometry systems, including OTOS that we tested.

Cycle Time Strategy

We used a public FRC team's pre-coded Google Sheet to input cycle times, strategies, and actions. The sheet automatically calculated point totals for cycles, points per second, and overall time, summarizing data like success rate, duration, and expected points per cycle.

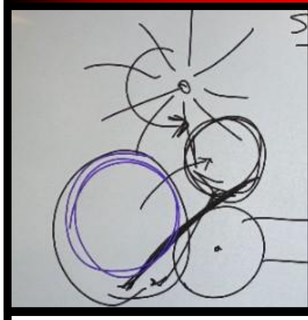
Action	Duration seconds	Success Rate	Expected Points
Drive to Launch Zone	2.5		
Shoot Classified Artifacts	9	75.00%	6.75
Shoot Overflow Artifacts	9	75.00%	2.25
Leave Launch	0.5	100.00%	3.00
Collect 3 Artifacts	7.5	99.00%	
Score Motif Bonus	0	33.33%	2.00
Drive to Artifacts	2		
Sort Motif	10	90.00%	1.80
Open Gate		100.00%	3.00
Overflow			1.00

OUR ROBOT — Spintake & Transfer

SPINTAKE

We wanted to create a ground intake so that we don't have to rely solely on a human player to provide us with artifacts. We also found that a smoother, less rough material with small tips at the end would hook onto the artifacts better, and let them go up to the transfer shooter in one clean motion. Something else interesting that we found is that the faster the rotation on the spin take does not correlate to faster ball intake. This is because the 6000 rpm motor just could not generate the torque needed for our spin take. But to stop the balls from getting stuck, we found a higher torque 1210 rpm Gobilda motor that was far more efficient. The filament we used for the spintake was a flexible type of filament called TPU. As we continued to test, we tried multiple variations of these "spiders".

Sketch

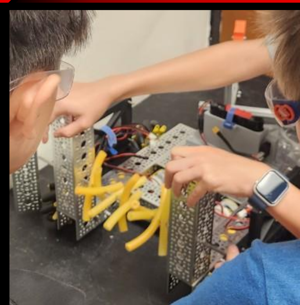


We started with a sketch of our basic idea. Our ideas involved one spinning axle parallel to the ground, or two spinning axles vertical and parallel.

Prototype

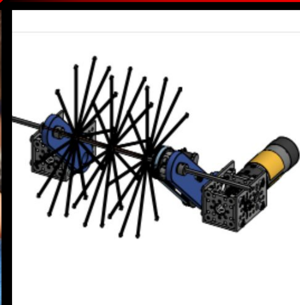
We made and tested prototypes using chopsticks as axles and using a variety of rubber tubes, plastic stars, vinyl tubes and other materials to see which performed best.

Innovate



Our prototype with rubber tubing had a decent rate of success but we wanted to improve our efficiency and tested out different 3D Printed prongs

Revise



Then we used flexible TPU 3d printed Spiders. We started testing different lengths, but we found that the one with thick, smooth, long arms worked best.

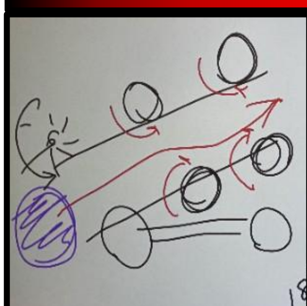
Embellish

We also found that the axle should be 5.5 inches away from the ground or 0.5 inch from the ball. The motor for the spintake kept interfering with other components.

TRANSFER

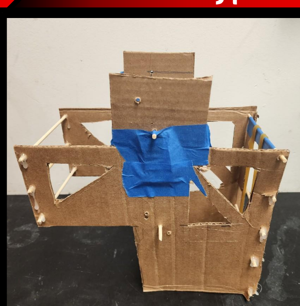
We realized for strategy and timing, that the artifacts could not go directly from the intake to the shooter because we need to be able to time our shooting and adjust the positioning of our robot and turret to point to the goal. Therefore we needed a transfer chute to hold our artifacts temporarily before we shoot. We went through many revisions as seen below. We started with a cardboard and tape prototype and worked our way up from there. We used pulleys and wheels to lift up the artifacts to our shooter but it was unrealiable. We realized a more simple ramp worked best.

Sketch



On day one of the competition being announced, we sketched out an early version of our transfer mechanism

Prototype

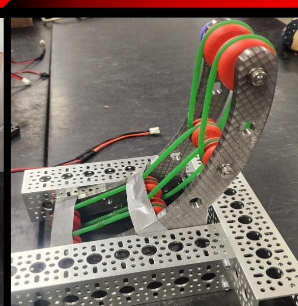


We quickly moved it to cardboard in our first prototyping meeting. We pushed the ball through with our hand to see if it would fit, and how well it would fit.

Innovate

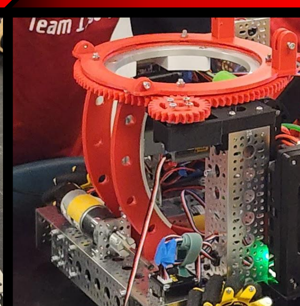
We made several CNC prototypes for our transfer. With the 18" tall robot constraints, we realized we made it too big and had to cut it down.

Revise



Once we were satisfied with our design, we created a 3D printed version of the transfer shoot. We used 6 pulleys and a series of 4 belts.

Embellish

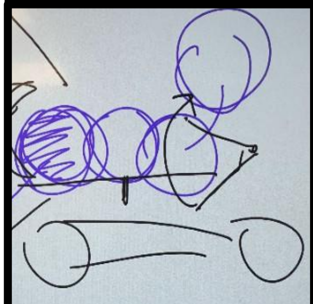


We realized our prior design was unreliable and sometimes simple is best. We redesigned our ramp for the transfer

SHOOTER

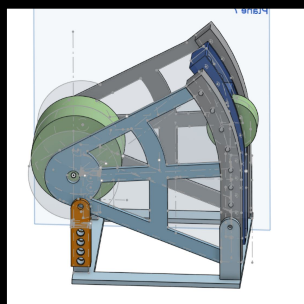
First we sketched out an initial design for our shooter. Though there was a problem with the shooter, the 6000 rpm Gobilda motor spun the flywheel so fast that it vibrated off some of the nuts. So we glued all the nuts that were on the inside to the 3D printed parts and we added stronger nuts for the outside where the wood was. Shooter: the flywheel doesn't have enough space. On the transfer mechanism the quad block was hitting the ramp. For the shooter, we made it out of a more sturdy filament called High Flow PET-G. We had 8 total iterations of the shooter.

Sketch



We had a couple of different concepts and we proceeded to try out two parallel flywheels in straight chamber, and then the angled larger and smaller flywheels in a more vertical cage.

Prototype

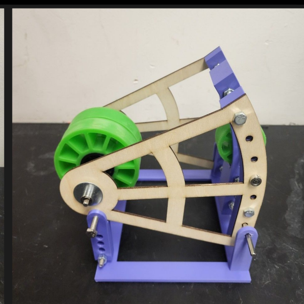


We tested both ideas out then decided to proceed with the upright cage because it gave the balls the loft we were looking for to help it score better.

Innovate

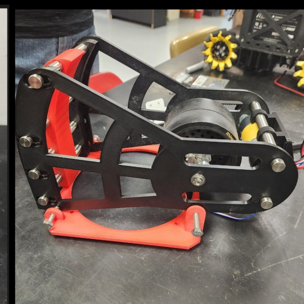
Then we took it to CAD and improvised it then we made it out of wood and 3D printed parts using a CNC laser cutter and a 3D printer so we could to test it.

Revise

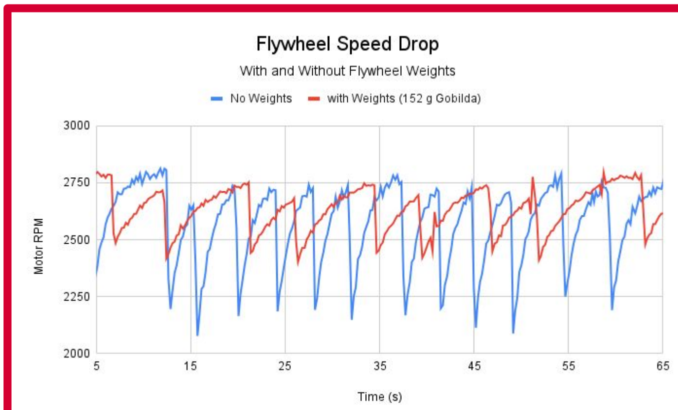


It worked quite well but it didn't have enough speed with the motor that we were using. So we swapped to a 6000 RPM motor that was able to give us plenty of lift and distance.

Embellish

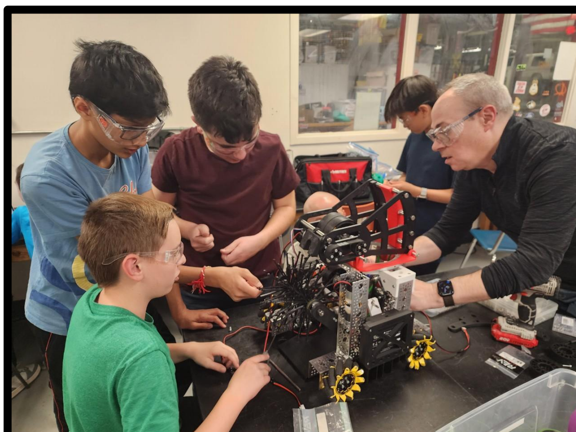


Our final version needed a spot for us to mount the motor. We also needed the ability to adjust the distance of the back wheel, so we made slots for the axles instead of holes.



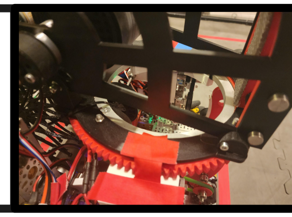
RPM Graph & Testing

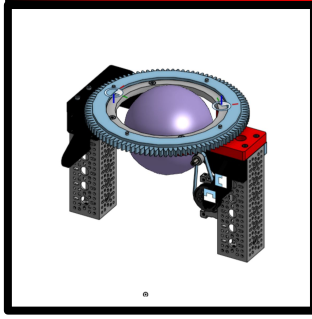
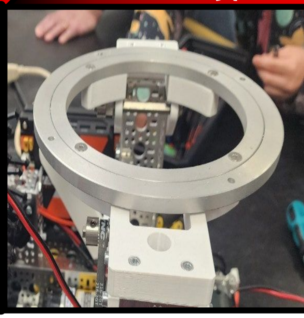
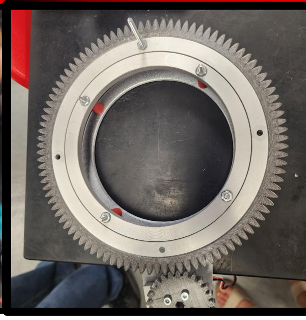
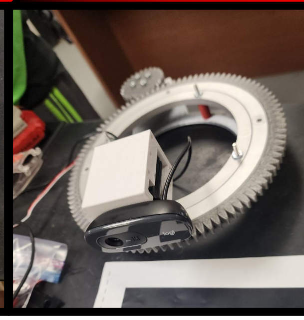
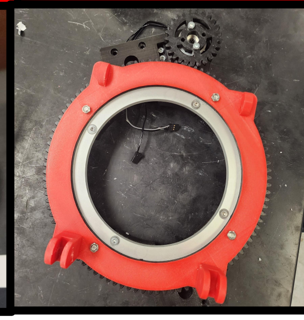
During our Decode season, we were using a GoBilda 6000 RPM motor for our flywheel shooter. During testing, we could hear the motor speed decrease as we launched Artifacts, but we didn't have data that speed was decreasing. To do that, we calculated the RPM (rotations/revolutions per minute), and then wrote telemetry data to a CSV file. From there, we used Google Sheets to graph the data to show our team what we observed (blue line). To reduce the RPM drop, we added weights to the flywheel, which resulted in lower RPM drops when launching Artifacts (red line) because higher inertia in the flywheel.

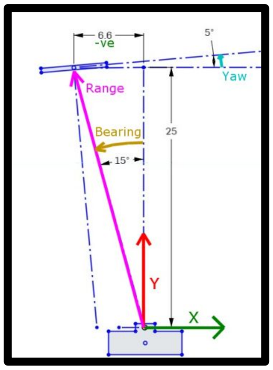


TURRET

Our Decode season's shooter mechanism featured a turret for constant alignment with the Blue or Red Goal, depending on our alliance. A turret, attachable to moving mechanisms, can be programmed to track field elements like Artifacts or Apriltags. We began with a sketch, then dedicated time to programming and refining the turret, including adjusting gears for operational limits to stay within the robot's 18x18x18 size constraints.



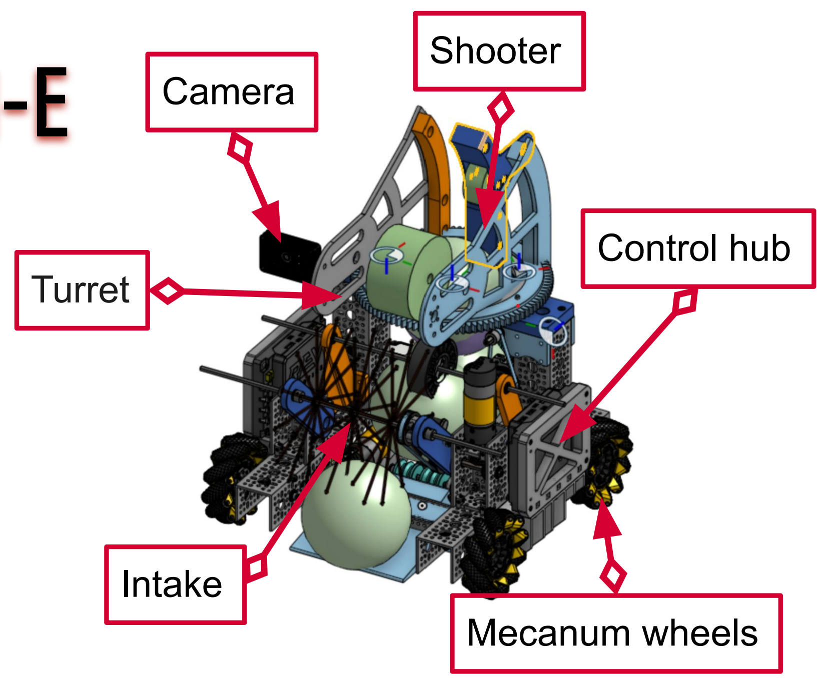
Sketch	Prototype	Innovate	Revise	Embellish
				



LimeLight Sensor & April Tags

We used a Limelight 3A for machine vision, which we put on our shooter, we read the April Tags' low-resolution QR codes that we can detect using machine vision and move the robot or turret based on it's position. We programmed this with our turret so that our shooter is always aligned with our Alliance Goal, making our precision better and getting more points in the end. To do this, we first find the tag and make sure that the camera is detecting the April Tag, then we find how far side to side our robot is (bearing). From there, we rotate the servo that is attached to the turret in order to align our shooter to the goal. We calculated distance using the April Tag to adjust the shooter motor speed.

Ball-E



We hope you have ***discovered*** the team you have been searching for in us, ***digging deep*** and ***decoding*** our portfolio. We wish you have a ***historical*** day for the ***ages***!