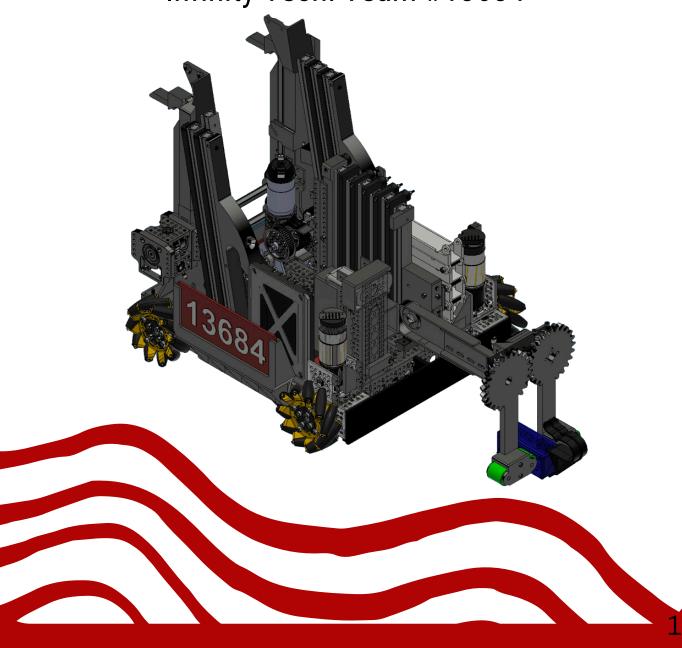


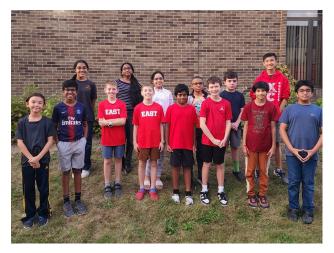
MUSSEL OUR WAY TO THE TOP!

Infinity Tech: Team #13684



ABOUT OUR TEAM

Mission: Sustain an infinite stream of technologists



Our Plymouth-Canton Community (P-CCS) team, Infinity Tech, was inspired by a 2017 FTC presentation that our founders watched. We now have 14 students, 9 mentors, and our robot, Mr. Mussel. This is now our eighth season competing in FTC! Explore our mission, design process, and outreach efforts in this portfolio!

Plan for Our Mission

	2020	2024	Infinity & Beyond!							
	 P-CCS FTC teams goes from 12 to 2 teams after COVID Our goal: Re-build FTC teams & sustain recruiting from FLL 	Co-led w/ FRC 5th grade recruiting event (3 new FTC teams from the event!!) Co-hosted official game rev for district FTC teams Lesson: Too many interest students & not enough mer	involved to help • 5th grade recruiting events fills open spots • Grow FLL teams co-located							
Elementary School										
Middle School	∞ ○	© 22 22 22 23 24 24 24 24 24	24 24 24 24 24 24 24 24 24 24 24 24 24 2							
High School	Lightning Robotics (High School FRC 862 Team)									
on Infinity Tech	Teams Directly	y Started by Infinity Tech	Teams started from Infinity Tech.'s co-hosted recruiting events							
Mentored by Infinity Tech	n FLL teams co-l	located w/ FTC teams	Other P-CCS Teams							





Meet Our Members

We are an infinitely amazing crew of 6th, 7th, and 8th graders from Plymouth-Canton Community Schools. We each have a focus in one of our subgroups: Design, Build, Program and Business, however we all still help each other in all aspects as well.



Edison - 8th Grade Status: Veteran Subaroup: Business Contributions:

- Portfolio
- Strategy



Parker - 7th Grade Status: Veteran Subgroup: Program Contributions:

- PID
- **Chassis**



Shivam - 7th Grade Status: Rookie Subgroup: Business Contributions:

- **Presentation**
- **Portfolio**



Surva - 6th Grade Status: Rookie Subgroup: Program Contributions:

- Joystick Bumpers



Ramanan - 6th Grade Status: Rookie Subgroup: Design Contributions:

- **Backup Human Player**
- Climber



Neha - 8th Grade Status: Veteran Subgroup: Build Contributions:

- Climber
- Gripper



Hudson - 7th Grade Status: Rookie Subgroup: **Programming** Contributions:

- Field-Centric
- PID





Luke - 6th Grade Status: Rookie Subgroup: Build Contributions:

- Climber
- Portfolio



Ivo - 6th Grade Status: Rookie Subgroup: Build Contributions:

- **Bumpers**
- **Linear Slide** Design



Bhagya - 8th Grade Status: Rookie Subgroup: Business Contributions:

- Portfolio
- Shirt Design



Alex - 7th Grade Status: Rookie Subgroup: Build Contributions:

- Prototype
- Climber



Parth - 6th Grade Status: Rookie Subgroup: Build Contributions:

- Claw design
- Linear actuator



Arisha - 6th Grade Status: Rookie Subgroup: Program Contributions:

- Autonomous
- **Claw Program**



Vid - 6th Grade Status: Rookie Subgroup: Program Contributions:

- Claw
- **Programming**





Outreach Impact

Throughout the year, our team hosts and attends a multitude of events, within different fields. These events include community outreach, engineering outreach, and more. We do our best to achieve the following goals while at outreach events:

> -Make robotics more well known within our community -Gain useful information for Build, Design, Programming, or Business -Interest the Roboticists of tomorrow

Team Outreach by the numbers (2023-2024)

Teams Mentored

926

Outreach Hours

Countries

|8,250+

People Impacted

FIRST Awareness

Community Service

Professional Community

Team Mentorship

Robots In The Park

Forgotten Harvest Food Bank

Detroit Based Creative

50-States Project

5th Grade Round-up

Trinity Food Pantry

Hyundai-Kia Lab

FTC Teams formed/mentored - 4 teams

Girls Gear Up

LMS School Cleanup

U of M Robotics Lab

Dodson FLL Explore - 5 teams

Social Media Posts

FTC Official Kickoff

Oakland University

Gallimore RoboFest Mentorship - 5 teams

Quiz Game Creation

EMS Robotics Showcase

FLL Challenge - 3 teams

Annual Global FTC Summit







Professional Help

Throughout the year, out team has reached out to several professionals, who have helped us reach our goals of individual improvement, and team improvement.



ORKLAND WVERSIT In October, our team was visited by Prof. Ka C. Cheok. He is well known within his field of Electrical Engineering, contributing to several recent innovations in the fields of computer vision/processing. His visit provided us some ideas from the real world and more. His visit was extremely helpful, and a relationship we hope to maintain.





In the days leading up to our competition, we had our Engineering Portfolio reviewed by a graphic designer. Derek Lamont, who works at GM for advertising, gave us tips and insights into things like picture hierarchy, order of reading, and color/spacing psychology. We hope to continue improving the portfolio with him, and thank him for his help in making our portfolio cleaner







Angela



Marshall



Ed





Eric



Tom



Karthikeyan



Cheryl

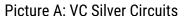
Our team mentors have helped lead us whether it comes to build, design, programming, and business. We have Coach Kanthan, an aerospace engineer at Airflow Sciences Corporation, Coach Angela, who works as an attorney at Pargon Legal Services, Coach Marshall who works as a license builder Monte Dean, Coach Ed a safety engineer at Hyundai, Coach Eric an engineering manager at Ford Motor, Coach Tom, an electrical engineer at Detroit Diesel, Coach Karthikeyan who works as a systems engineer at Siemens, and Coach Cheryl who is a business owner of Twinkle Twinkle Little Store.





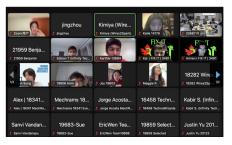
Team Mentorship

Throughout the last two seasons, our business team has been working on a super project dubbed "50-States Project" or "Project Expanse". After 2 years, and over 100 hours of total outreach, we've emailed or Zoom called a team in every state in the US. Teams such as VC Silver Circuits (Picture A), gave us insightful information into how they manage their robot, and Sushi Squad gave us tips on our future outreach events.















In addition to Project Expanse, our team has attended a summit hosted by two of the teams we reached out to, Sushi Squad #14179 and Treeman #19600. We discussed what we had done for the past year, both in robots and outreach. The summit included more than 40 teams, from places like China, France, Brazil, and Mexico.

Paying the help forward, we do our best to mentor/establish new teams. We'e provided aid to local FTC teams such as the Liberty Bees #25721 and Comet Robotics #25828. We also mentor a total of 13 elementary school teams, both in FLL and Robo-fest.





6



Brainstorm & Strategy

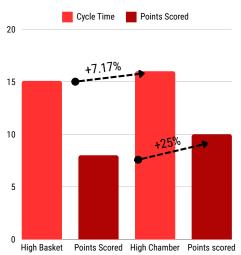


Figure B: Graph of Statistic Analysis

Statistic Driven Strategy

Shortly after the game reveal, we developed our strategy by running simulations to optimize points. Initially, we thought the High Basket would score more points/sec than the High Chamber; however, the opposite was true. In the end, we found that a 7.17% increase in cycle time meant a 25% increase in points (See Figure B). Since the High Chamber was more efficient, we began to gear our designs toward the Chambers, as well as our strategy (See Figure C). If you would like to learn more about our process, visit us in the pit.

Final Strategy

See visual guide in Figure C

Specimen Strategy:

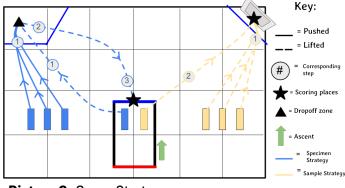
- 1. Push/pick up sample, place in observation zone
- 2. Pick up specimen
- 3. Deliver specimen to chamber

Basket Strategy:

- 1. Pick up alliance neutral samples, score in basket
- 2. Go to submersible, pick up samples

End Game Strategy:

- 1. At ~28 seconds, drive to ascent zone
- 2. Ascend to Level 3
- 3. Start earlier if we are unable to score



Picture C: Game Strategy

Cycle Time Improvements by Event 80.0 Average Seconds / Sample Average Seconds / Specimen 40.0 Time (s) 20.0 Pre-Qualifier Qualifier #1 Qualifier #2 State

We modified and added mechanisms to our robot, decreasing cycle time, our improvement logged below:

Pre-Season: This is our performance pre-competition, which serves as our benchmark

Qualifier #1: We introduced new methods of collecting samples and specimens, as well as precision mode Qualifier #2: We enhanced both our gripper and lift State Championship: We enchanced our gripper, and introduced Hybrid mode



Design Process

During the season, our build team follows a process called "S.P.I.R.E.". Using our version of the Engineering Process, which consists of 5 steps, we turn an idea to a reality. Below is an example of this process.

Essence of S.P.I.R.E.



Prototype

nnovate

mbellish

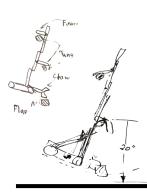
Our first step towards a physical piece starts with getting our idea represented through a rough sketch. During this phase, markers and pencils are our medium.

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 Fusion 360 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

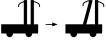














During the season, our build team documents a more specific and comprehensive journal of our team's build iterations. This helps us learn from our mistakes, and creates more awareness throughout the team.





Meet Mr. Mussel



Meet our robot, Mr. Mussel. Our robot has many mechanisms such as a sushi roll gripper. It also has a double mussel climber. We call him Mr. Mussel because he does a pull up.

Climber Mechanism

Our Climber is comprised of two separate sets of slides. One for the low rung, and one for the high rung. In contrast to previous seasons, our climber is composed mainly of 3Dprinted brackets and hooks. For more info, see Page 8.

Gripper

of a set of double sided claws, is our method of scoring. Like the climber, the gripper has been printed in PETG filament, which is both robust, and allowed us to go through iterations quickly. To learn more, refer to Page 7

Clam Shell

The Clam Shell is made of PETG filament, and was made to protect the robot. In addition to this, the plate serves as a way for us to quickly push samples, increasing our efficiency. See Page 9 for more.

Seahorses

The Seahorses dampen the swinging motion our robot makes after achieving the Level 3 Hang. This prevents the odometry from being damaged, which had previously posed a problem to us.

Reel Sensor

The Reel sensor tracks how far the slide has worked, making sure that where the motor thinks it is correct, ensuring we are able to score more easily.



Gripper

Figure D: Mechanism Evolution





We went through 9 iterations (see Figure D), 5 of the most significant are displayed above. We had to alter the claw many times, reasons listed below:

- 1.) Didn't fit the sample/specimen, and required two servos
- 2.) Could not fit long edges of sample, but reduced design to one servo
- 3.) Made the gripper able to grab sample/specimen more seacure in certain orientations, but still difficult to grab on long edge. We also changed the claw to grab from above, rather than in front.
- 4.) Changed from 3D-printed to rubber "sushi rollers" to increase adaptability and stickiness, but we can't pre-load (see in lessons learned below)
- 5.) We landed on a double-sided gripper, which solved our size constraint

On many of our mechanisms and designs, we use a more unique design for our gears. This style is called Herringbone gears, and they resemble a score of V shapes. This design, which was recommended by a fellow team, allows for further precision, and prevents the gears from slipping. Gears such as these are completely open source, and are a concept we recommend to teams with gearing problems.



Lessons learned

We found that with such a large claw, due to its distance from the ground, we would have to rotate the claw inwards to meet the 18 x 18 size constraint. However, this meant we would not be able to pre-load a specimen. To fix this, we added another side to the claw, so that it can score in auton, and stay within required space

Pros/Cons list

Pros:

- Adaptable to different orientations
- Light and interchangeable in case of damage
- Easy to replace and revise with CAD/3D printing

Cons:

- Does not hold an extremely strong grip
- **Gripper sometimes** over/undershoots sample, due to overhead pickup
- Gripper is not fully optimized





Climbing Mechanism

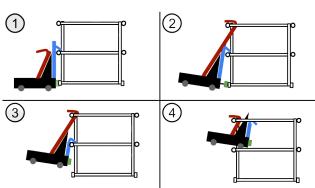


Figure E: Our climbing process;

Design and Functionality

Our climber consists of 4 steps:

Step 1: Hang on low rung bar & lift off the ground

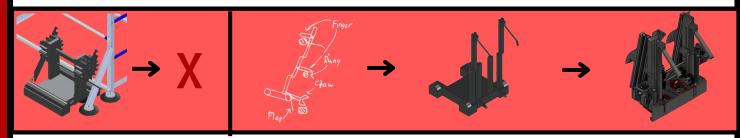
Step 2: Two servo-driven rack & pinion actuators position the robot for high rung hang

Step 3: Pull-up on both low & high rungs

Step 4: Achieve a Level 3 Ascent (if desired)

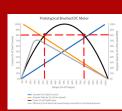
See Figure E

Mechanism evolution



How we improved our Climber using math

- 1.) Calculate work: = mgd = (14.6 kg)(9.8m/s^2)(1 m) = 143.2 J
- 2.) Calculate power: W/t =143.2 J / 2 s = ~71.6 W
- 3.) Compare power result w/motor power output to DC motor curves (Figure F)
- 4.) Find motor with similar Torque/Speed ratio &
- 5.) Keep improving to find optimal times (Figure G)



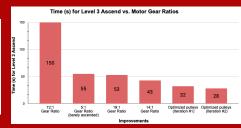


Figure F: DC motor curve

Figure G: Times and changes

Lessons learned

- Calculations & reality can be different due to friction & forces not in CAD
- Every change comes with a tradeoff
- First idea is rarely the final idea
- The quicker we test, the faster we learn

Pros/Cons list

Pros:

- 3D-printed parts are easily redesignable
- Light and durable hooks
- Able to hold 30+ pounds

Cons:

- · Climbing is a 3-step process, more room for error
- 3D-printed parts are more
- · Climber is relatively wobbly, due to slides having weight





Key Issues - Building

Problem

Throughout our qualifiers, we found that our belts slip if put into awkward positions, creating gaps between where the motor thinks it is and where it really is. Instead of tightening the belt, which presented a different set of challenges, we attached odometry pods (Nicknamed the Reels) to the slide. These count the distance the slide goes, and cross-references to ensure accuracy. If the odometry count and motor count don't match up, the slides adjust, hitting the same height, regardless of belt slipping, among other issues.

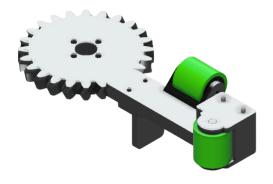
As in many seasons, mistakes happen. But mistakes help us learn too. During our drive team practice, parts of the robot became damaged by collisions with the walls and submersible. This led us to 3D-print and design bumpers. Printed with PETG, these bumpers are solid and sturdy. In addition to protection, the bumpers serve as a way to push samples,

We found that with such a large claw, due to its distance from the ground, we would have to rotate the claw inwards to meet the 18 x 18 size constraint. However, this meant we would not be able to pre-load a specimen. To fix this, we added an additional roller to the opposite side. This gripper part is used only in auton, but solves the problem given, and increases the likelihood our auton works.

Solution







Our double-sided claw, which allows us to fit within size constraints

Programming - Developments and Goals

At the competition season start, our programming team compiled a list of goals for their season;

- 1. Make driving and operating as intuitive as possible
- 2. Score multiple elements during Autonomous
- 3. Prevent robot damage through errorproofing.

To reach these goals, we used a variety of sensors and concepts, some of which are listed below:

Autonomous Mode:

Grip Sample

Move forward 4 feet

Turn Left 70 degrees

Odometry/Deadwheels

We incorporated odometry pods into our robot. They help us track our current position and movement with encoders, aiding autonomous' accuracy. These pods are provided by GoBilda, but the journey learning to utilize it provides great learning experience.





Pedro Pathing Library

We used a technique called Pedro Pathing (See more on next page) to code our autonomous. Pedro Pathing is composed of poses, which position the robot, and cases, which string together the poses. We switch between cases, leading to an easily manageable autonomous program

Put wrist down Auton Function Call: Red Blue Yellow **Purple**

Our team aims to make driving and operating the robot intuitive. We use different concepts and programming styles to error-proof the robot's movements, increasing efficiency and minimizing damage.

Tele-Op Mode:

Field and Robot-Centric

- We learned more driving options, Field & Robot-Centric in the off-season
- We've found situations where one option can be more advantageous than the other so we added a function to switch between the two, increasing efficiency



Field-Centric: Absolute orientation



Robot-Centric: Relative to itself

Precision Mode

We added another mode called precision mode in order to avoid twitching and jerking near scoring areas. This decreases the wheel speed by ~50%, increasing our scoring efficiency, shown with this graph:

Samples/Specimens vs. Precision mode on/off







Key Issues - Programming

Problem

In order to make our robot more balanced, we created a hybrid mode. By pressing a button, we go from the same spot in the observation zone to the same spot on the chambers. This decreases human error, and decreases our cycle time ~[Insert seconds here] seconds. This uses components of our autonomous, Pedropathing, to increase efficiency.

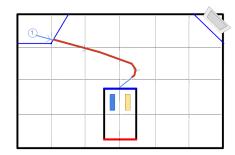
While programming the slide, we found that the slide would move up past the desired position, then move too far down past the position again, and repeated this cycle until it settled into the correct position. This got us to scoring position, but it took way too long, and caused variance in scoring. Our programming team fixed this with PID, or Proportional Integral Derivative. This allows us scale the amount of power in the motors, and slim down the time to get to a specified position.

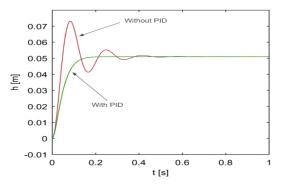
Due to weight distribution and the nature of our mecanum chassis, the robot's movements were inconsistent. Drifting and jerky movements made scoring more difficult, especially considering the precision required to score on both the chamber and net zones. To fix this, the programming team tuned the robot, and incorporated SIS (Square Input with Sign). This changed movement from being linear relative to the joystick to being exponential, with a small ramp up and down to minimize twitching and jerking.

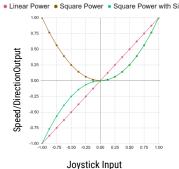
In years previous, our programming teams have relied much more on hard coding, which means strict instructions with specific directions. The problem with this however, is that if any variable is off, the entire auton won't work. Enter Pedropathing, which is easily manipulated, and integrates sensors more seamlessly. More information can be found on the page previous.

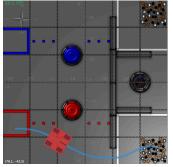
Solution

Blue Line = Driver Controlled | Red Line = Autonomous

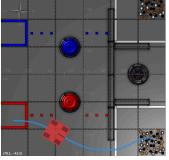












Team Skill Development

Developmental Areas		Feb	M a r	A p r	M a y	J u n	Ja-	A u g	S e p	0 c t	N o v	D e c
Recruit new members (Interviewing skills)												
Set-up Android Studio (Learn about IDE / tools)												
Bread board / Chassis-only (Basic motor, sensor, servo> component-level)												
Fix past robots (2025 Plan) (Understand system-level)												
Co-locate with FRC (Connect to the next step)												
Company / Sponsor visits (Connect FTC skills to careers)												
FTC Competitions (Apply learnings)												
Teach Java Language (Connect to FRC & career)												





Programming - Skill Development

Throughout the season the team members that are on our team seek to help them learn and grow in their field, ultimately setting them up for their future careers/passions. For programming team, we seek to improve their skills by:

-Interacting with more experienced figures within the programming community -Providing an appropriate difficulty for each member, encouraging growth -Using provided resources to understand Java on a fundamental level

Throughout our off-season, we train our programming team through the use of sheets and videos to help develop their skills. This sets our team up for a productive and successful competition season. Beyond this, the language we use, called Java, is also used by our local FRC team, Lightning Robotics, who provides us mentorship through team members and online courses, allowing us to grow and learn at any time. For a more in depth explanation, refer to the page previous.



Thank you Judges!

Dear Judges,

Thank you so much for spending your Friday and Saturday with us! Your dedication, passion, and fin-tastic work really means the world. Events like these give the next generation more learning experience and time to learn from whale-ure. Again, thank you for your jaw-some work to **kelp** the roboticists of tomorrow.

Sincerely, Infinity Tech Robotics #13684

Pun Count :) = 5



