TARDIS 5356

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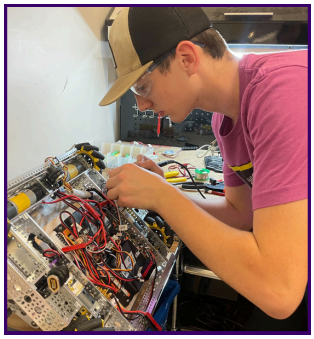


ENGINEERING PORTFOLIO 2024-2025

FIVE THINGS NOT TO MISS TODAY:

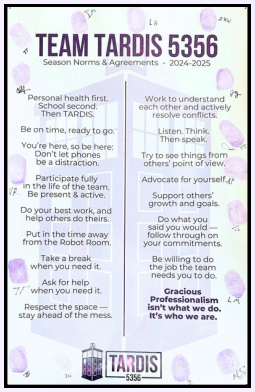
1. CHECK OUT OUR 3RD GEN. INTAKE AND TESTING DATA! WE CUT OUR TIMES IN HALF! PG. 6
2. WE ABANDONED OUR 3RD LEVEL ASCENT SUBSYSTEM; READ OUR COST-BENEFIT ANALYSIS PG. 7
3. WE REDUCED HUMAN ERROR W/ AUTOMATION AND SENSORS PG. 8 & 9
4. WE TAUGHT 115 TEAMS AROUND THE WORLD AT OUR WORKSHOPS PG. 11
5. WE'VE TAKEN THE FIRST STEPS IN FOUNDING A NEW FTC TEAM IN OUR TOWN PG. 13

PLEASE NOTE: OUR PORTFOLIO KEY

In this document, **purple text indicates core concepts or team baselines.**
Red text indicates threats, concerns, shortcomings or obstacles to success.
Green text indicates decisions, growth, success, achievement, and outcomes.

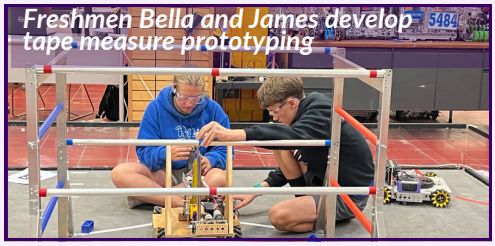
'24-'25 TEAM GOALS & SEASON FOCUS

- **Maintain our focus on being a student-led team**
  - **Students set goals and direction** with support, guidance and instruction from mentors and coaches.
  - At the same time, our coaches and mentors' **questions can lead us to better outcomes** because they help us **think through our decisions, situations, or consequences.**
    - We saw an opportunity to **redesign our intake subsystem** after our first competition, and again after our final qualifier – **they worked, but we wanted to be better.** Our coaches noted that a redesign on a tight schedule was a risk, and later that a redesign could **potentially put our season at risk. We created a timeline to follow, accepted the risk, and committed to the redesign — and it works! (see pg. 6)**
- **Expand assistance and expertise to other FTC teams globally**
  - **See our map on page 11 to learn about our incredible success!**
- **Increase professional-based STEM outreach in our community**
  - See page 13 for details on **how & why we are looking to expand our reach.**
- **Increase youth-based STEM outreach in our community via engagement with local schools and community events**
- **Use and learn from our data**
  - Collecting data has been crucial in **determining the optimal game strategy,** ongoing intake development **(and if we were ACTUALLY improving our cycle times – see page 5),** and in improving our autonomous pathing!
- **Compete with a versatile, efficient, and robust robot throughout the season to qualify for Worlds in Houston, once more!**
- **Improve team culture, time management, and general health of members**
  - At the beginning of this season, we established a list of **Season Norms and Agreements (at right)** to establish a shared work ethic and team culture.
  - To compete at the highest level, we must ensure a sustainable and healthy team, and we will commit to **taking our team members' mental health seriously.** For more on details, **see page 15.**

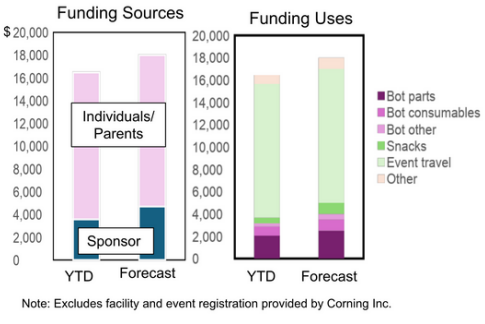


TEAM TARDIS 5356,

founded in 2011, is a community team in New York's Southern Tier with 15 members and 10 mentors and coaches who love robots and strive to share STEM within and beyond our community.



FINANCIAL PLAN



Note: Excludes facility and event registration provided by Corning Inc.

CORNING

As set in policy by our sponsor, Corning, Inc., **we are not allowed to engage in fundraising.**

Instead, time and energy we would use on fundraising goes to **robust outreach in our community and beyond.**

The charts above document our **sources of funding and expenses this year.** We are grateful to Corning, Inc. for their 13+ years of support and the opportunity to actively give back to our community year after year!

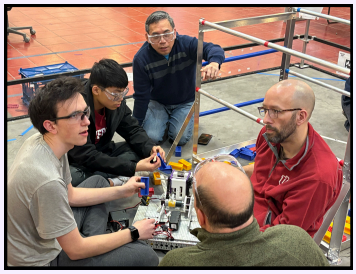
SUSTAINABILITY & LEARNING PLAN

- This season, we have a young team (10 of 15 are first or second year members), and **two senior members will graduate**
- To ensure a strong future for TARDIS, we have a **strong learning plan to help onboard new members and grow skills:**
  - New members **first focus on a field of interest** beginning in off-season training each May: building, design, programming or documentation
  - By October, **our first-years are given a subsystem to develop** within the Engineering Design Process; this year, it was the 3rd level ascent device (see pg. 7)
  - By mid-season, **2nd and 3rd year members take on more responsibilities** as our seniors scale back their presence when possible
  - Much of our outreach targets an FTC-eligible audience, which helps our team **recruit and prepare new members; seven of our current members are Camp TARDIS alumni!**

HOW WE GAIN NEW MENTORS

As we continue to grow within our community and beyond, we are lucky to **have an abundance of mentors to learn from.** This year, we gained **three new mentors –** two through team members' families and one through a previous visit. With so many skilled mentors, we only reach out for more **when we identify a need to improve in a certain area or we need to learn new skills**.

For example, we reached out to **Steve Miller, a retired VP of Strategy** for Corning Inc., **for assistance in game & data analysis and documenting our financial plans and structure.**



MEET THE TEAM: OUR CONTRIBUTIONS AND POINTS OF PRIDE THIS SEASON

4TH SEASON MEMBERS

Thai, lead designer & builder - "I'm proud of our persistence in robot improvement, interview improvements, and our 5-sample autonomous."
Tristan, designer & builder - "I'm proud of our effective drive team strategy, scoring improvements, and improved electrical organization."

2ND SEASON MEMBERS

Thang, co-lead programmer - "I'm proud of our improvements in programming, the development of the Gen3 intake, and the growth us programmers have made this season."
Eavan, co-lead programmer - "I'm proud of our two online global portfolio workshops, our Gen3 intake, and our consistent autonomi."
Isaac, designer & co-lead builder - "I'm proud of our maintenance, community outreach, and Project 29K."
Luke, co-lead builder - "I'm proud of improving maintenance checklists, and building the new test bed and competition bot chassis."
Adam, builder - "I'm proud of Camp TARDIS, the maintenance list, and our demo bots."

3RD SEASON MEMBERS

Dean, team lead, designer & builder - "I'm proud of our successful Gen3 intake, our global outreach, and our extendo linkage."
Nicole, lead documentarian & outreach coordinator - "I'm proud of our global outreach, new outreach programs, and being able to individually provide teams portfolio feedback."
Victor, design, TeleOp programmer - "I'm proud of debugging the lift programming, Project 29K, and the deposit-to-state command."

1ST SEASON MEMBERS

James, builder - "I'm proud of the tape measure winch & its iteration board and the skills I've learned."
Lincoln, builder - "I am proud of my work on the winch, the iteration boards, and the skills I've learned."
Liam, builder - "I am proud of our CADing, design, assembly, and testing for the winch design."
Bella, builder - "I'm proud of my work on Camp TARDIS, the tape measure winch, and the shielding."
Jacob, documentarian - "I'm proud of our intake progression and our portfolio and global outreach."

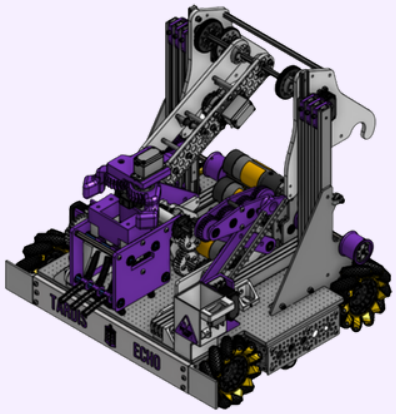
COACHES & MENTORS

Trung Tran - head coach; dentist
Michael Simons - documentation & outreach coach; high school teacher
Penny Chung - assistant coach; high school teacher
Garrett Piech - programming coach; process engineer
Ken Moyer - CAD and machining mentor; CAD and process engineer
Paul Dohn - founding & build mentor (2011); Corning Inc.
Will Boychuck - programming mentor, Upsilon Robotics
Kalina Roussev (new) - portfolio mentor; audience experience designer at the CMoG
Steve Miller (new) - finance & data mentor; retired VP of Optics Strategy, Corning Inc.
Mike Walker (new) - mech. & CAD mentor; mech. engineer

THANK YOU ADULTS!

OUR CAD JOURNEY

- CAD has become a crucial part of our design process, as it allows us to **create highly accurate and precise models** and pre-visualize subsystems on our robot, ensuring they fit together seamlessly
- Three years ago, we started exploring CAD on our own, and **last year we gained a full-time CAD mentor** from the local STEM community. **This is our first year with a fully CAD-ed robot — a major goal and milestone for our team!**



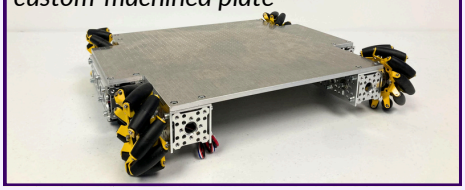
A NEW OPPORTUNITY

Problem: We felt **restricted by off-the-shelf and stock FTC parts**, which gave limited configurations when building. **Solution:** A tour and presentation about FIRST during a May 2024 outreach at Hilliard Inc. resulted in the generous **offer to cut a custom plate that we designed in CAD!** Our outreach experiences yield results!

See Pg. 12 for more!

The plate as it is being machined

Our drive train with Hilliard's custom-machined plate



SEASON PLANNING, STRATEGY AND DESIGN PROCESS

Gallery walk after silent brainstorming

Interacting w/ field elements @ Game Launch

EVERYONE'S HEARD WHEN WE'RE ALL QUIET: SILENT BRAINSTORMING

- In September we spent **over 270 person-hours of meeting time** analyzing the field and game elements, coming up with optimal strategies, etc.
- **We're a large team of 15 students and 10 coach-mentors.** Silent brainstorming (above) **ensured all ideas were heard, as it is important to us that everyone has a voice**

This year, silent brainstorming, in conjunction with full team planning meetings, resulted in an **early-season unified vision and game plan,** delivering a stronger long-term plan for a robot design that has grown with us all season.

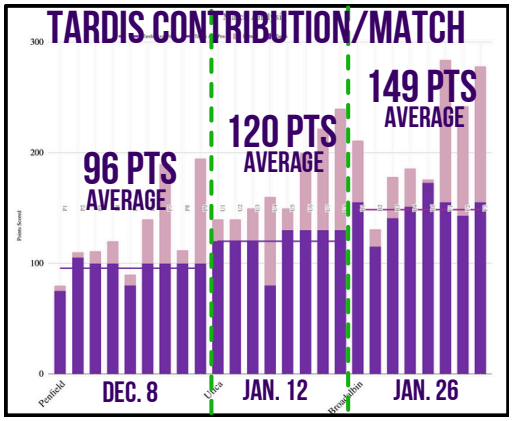
OUR GAME STRATEGY FOR INTO THE DEEP

- Strong focus on autonomous, as almost every point scored is effectively worth double in driver-controlled
  - **Maximized auto - 53 pts "5+0" specimen side; 43 pts "0+5" basket side w/ parks**
- A versatile active intake, gripper, lift & teleop that **scores both specimens and samples**
- Our well-trained **human player and drivers communicate well** with each other to **optimize submersible & basket cycling**
- We **communicate & plan with our alliance partner** before the match to **optimize auto and in-game scoring strategy**
- **Achieve Lv. 2 Ascent instead of Lv. 3,** favoring 3-cycle specimen scoring time and **earning +15 point advantage (45 vs. 30 points) in the same time**

DATA-DRIVEN DECISIONS: SWOT+MATCH ANALYSIS

Starting in December, we use **SWOT analysis and match scoring analysis** to support discussion and decision-making throughout the season as our robot and team evolve competition by competition. **We improved by an average of 50 points from our first to third competition.**

Analysis sessions result in **itemized task lists and project management plans** that guide future development in January and beyond.

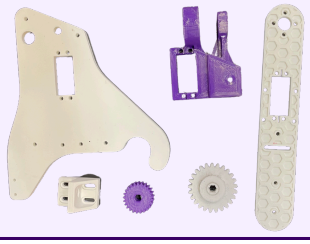


FLX, Utica and Broadalbin Match Analysis

3D PRINTING

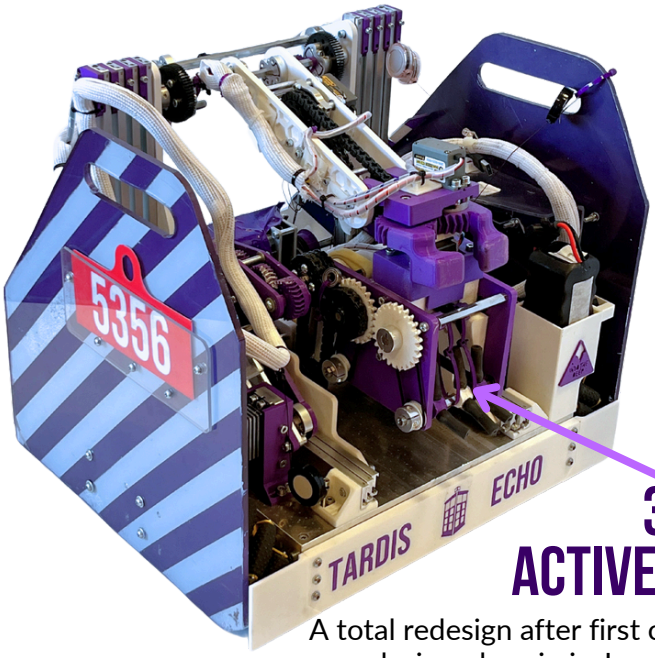
3D printed parts are integrated into every subsystem on our "Into the Deep" robot, Echo.

- In our design and development this season, **we used 3D printing for rapid prototyping, fabricating custom parts**
- In the past two seasons, team members have **purchased 3D printers for home use** away from our club space, allowing us at-home time for development
- We used 3D printing extensively in **our intake's development, rapidly iterating multiple concepts** to assess feasibility and reliability for gameplay



A few of Echo's custom 3DP parts

MEET ECHO



GRIPPER

Servo automatically closes the gripper once it detects a Sample or Specimen; grip tuning allows Specimen to orient to correct position via gravity on transition to scoring position

ARM

Parallel 3D-printed plates deployed by two servos, to pre-programmed set points, reducing human error in scoring and facilitating automatic intake-to-gripper handoff while driving

HANG

Integrated 3D printed hooks in our "shoulders" enable efficient Level 2 ascent; hook profiles were prototyped and rapidly iterated during development

3RD GEN ACTIVE INTAKE

A total redesign after first competition, redesigned again in January; **has cut intake time nearly 60%!** Rapidly prototyped in CAD & 3DP. Utilizes rubber tubing 'fingers' for a "touch it, own it" strategy; modular inserts allowed rapid testing of different tolerances for Sample control and internal profiles on the intake

EXTENDO

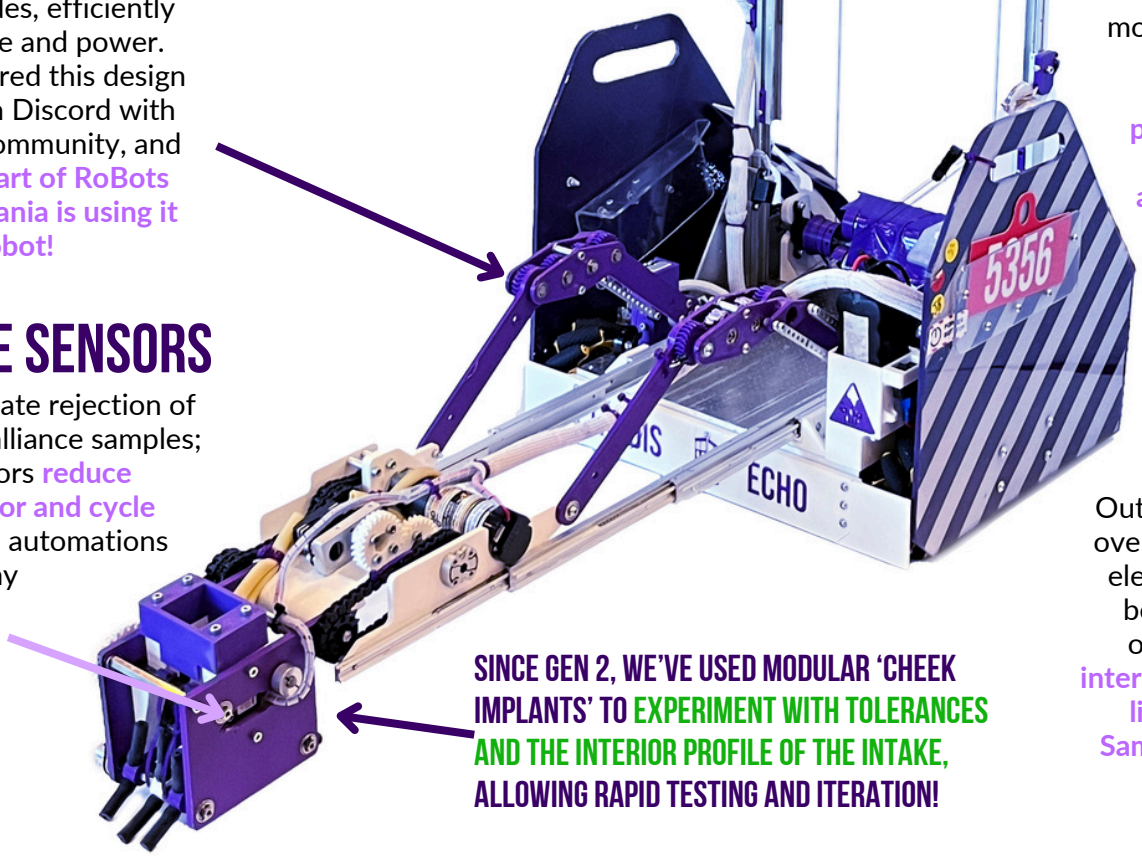
Twin reverse 4-bar linkages extend slides, efficiently using space and power. We've shared this design globally on Discord with the FTC community, and 20265 Heart of RoBots from Romania is using it on their robot!

LIFT

Uses SAR230 slides, three 435-RPM motors and continuous rigging to extend; pre-programmed positions make game piece transfer and scoring/delivery more efficient, minimizing human error and increasing cycle times

INTAKE SENSORS

We automate rejection of incorrect alliance samples; color sensors reduce human error and cycle times with automations in gameplay



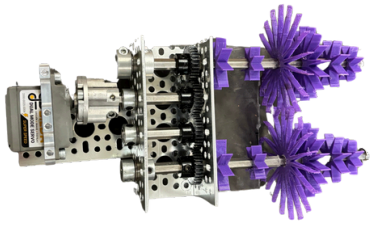
SINCE GEN 2, WE'VE USED MODULAR 'CHEEK IMPLANTS' TO EXPERIMENT WITH TOLERANCES AND THE INTERIOR PROFILE OF THE INTAKE, ALLOWING RAPID TESTING AND ITERATION!

SHIELDING

Outer shielding prevents over-possession of game elements and allows for better protection from other robots; likewise, internal shielding reduces likelihood of getting a Sample stuck within our chassis and getting a possession foul.

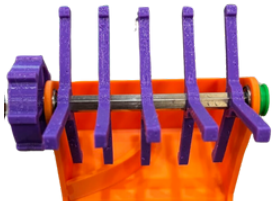
INTAKE MECHANISM DEVELOPMENT

PROTOTYPE 1



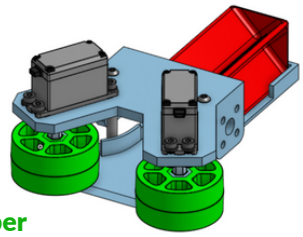
- Bristle cone active intake
- We experimented with different sizes and shapes of bristle fingers, powering the prototype with a hand drill
- **Large and difficult to intake and outtake**

PROTOTYPE 2



- Added a bottom roller and top finger
- Smaller than the Prototype 1
- Different bristle fingers tried again; shown below is one of many designs
  - 3D printing allowed for quick iteration
- **Intake failed to control Samples**

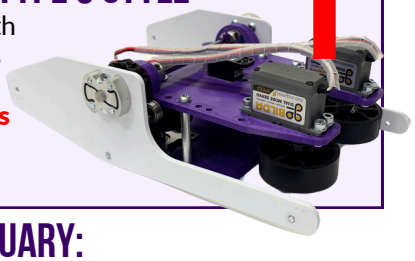
PROTOTYPE 3



- New Gecko wheel mechanism was able to intake Samples from **almost any orientation**
- Fixed the **intake control problem**
- **Slower, but functional for December**

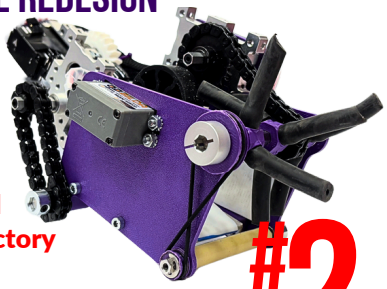
FIRST GENERATION - DECEMBER: PENFIELD DESIGN - PROTOTYPE 3 STYLE

#1



- 4 rubber wheels worked with a servo to angle downwards to reach Samples
- **Intake times averaged 8.05s at competition; we abandoned this design**

SECOND GENERATION - JANUARY: UTICA DESIGN - A COMPLETE REDESIGN



#2

- 3-fingered hubs with black silicone tubing fingers
- Single rubber wheel to control the sample's alignment for transition to the gripper
- **Cycle times averaged 7.38 and 6.57 at competition; unsatisfactory for Championships**
- Continually pushed samples away from the robot because we used an end-on approach – **required a high level of precision**
- **Servo power was too slow**

However, this intake still proved to be less efficient than we had hoped, **gaining only 1.5 sec. of better performance on intake,** leading to our desire to continue to improve it.

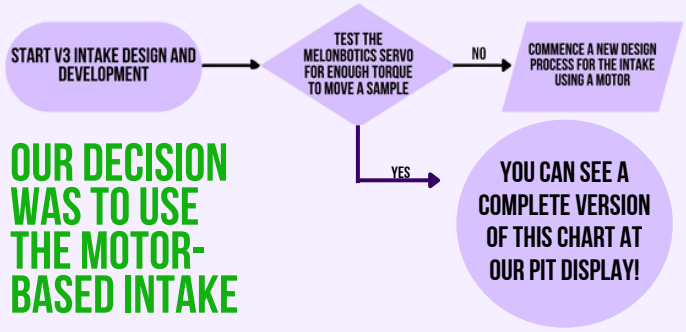
BACK TO THE DRAWING BOARD, AGAIN: OUR THIRD GENERATION INTAKE

Our match analysis showed 8.03, 7.38 and 6.57 second pick-up times at Quals – we needed better performance.

Our design team **proposed two options for a third, redesigned intake,** but knew **time was short**. **Option 1:** a servo-based intake; **Option 2:** a motor-based intake. We created a flow chart to guide decision-making, **we discussed the risks and came to consensus:**

We'd try a third total redesign for Championships!

To proceed, we needed to evaluate servo performance:

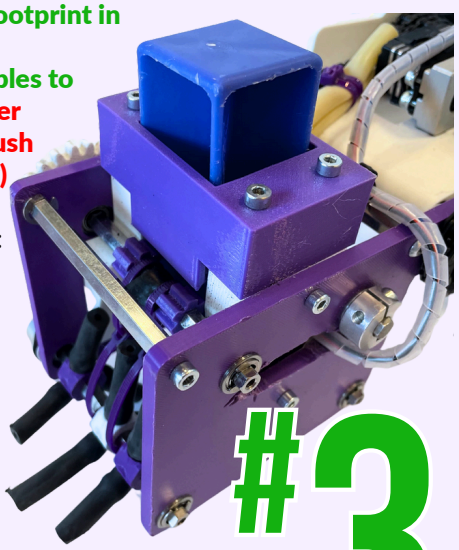


OUR DECISION WAS TO USE THE MOTOR-BASED INTAKE

3RD GEN GOALS & DESIGN CONSTRAINTS

Based on our match analysis, we determined our **3rd generation design constraints and goals** to be:

- **Virtual 4-bar linkage** to intake the samples from above, **minimizing our footprint in the submersible and pinning samples to the ground (earlier designs would push the sample away)**
- Use a motor to power the intake: **faster and more torque**
- Transfer out the sample from the top so we could **keep the same arm and gripper**
- Continue using **rubber intake fingers** because they **worked well on Gen2**
- Keep implementing the **modular cheek implants for efficient iteration**



#3

SEE OUR DATA & OUTCOMES ON THE NEXT PAGE!

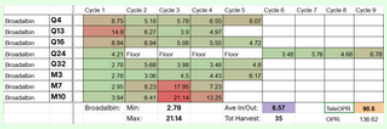
CAN WE TRY IT AGAIN? YES!

Developing a **second and third-generation intake,** each with a completely different design **was a risky move, with only two weeks to design, iterate and test each concept to viability.**

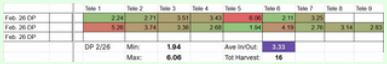
Our **growth in CAD and designing** for manufacturing, and our skills in 3D printing **allowed us to rapidly iterate and test our way to success** — testing showed each new intake functioned more efficiently than the previous!

GOAL REACHED: 3RD GEN INTAKE A SUCCESS!

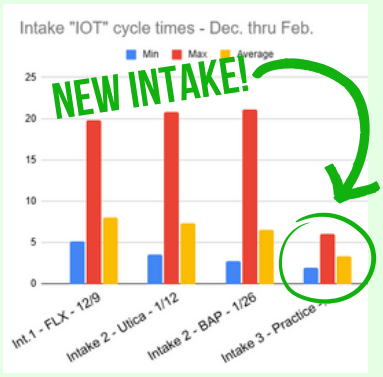
CYCLE TIME DATA FROM OUR 1ST GEN INTAKE



CYCLE TIME DATA FROM OUR 2ND GEN INTAKE

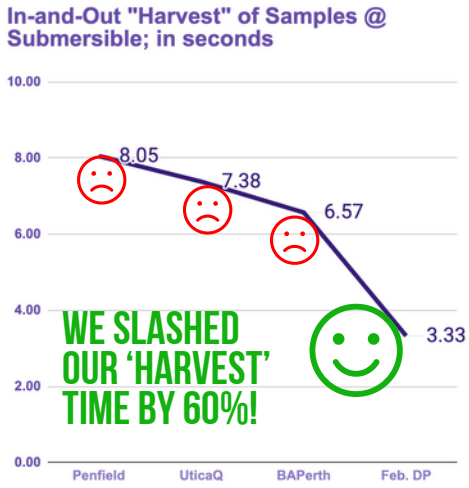


CYCLE TIME DATA FROM OUR 3RD GEN INTAKE



MIN/MAX/AVE TIMES, DEC-FEB

Analysis of our qualifier matches and driver practice show that our **3rd gen intake significantly improved cycle time.** Additionally, our data shows that our **new intake is significantly more consistent!**



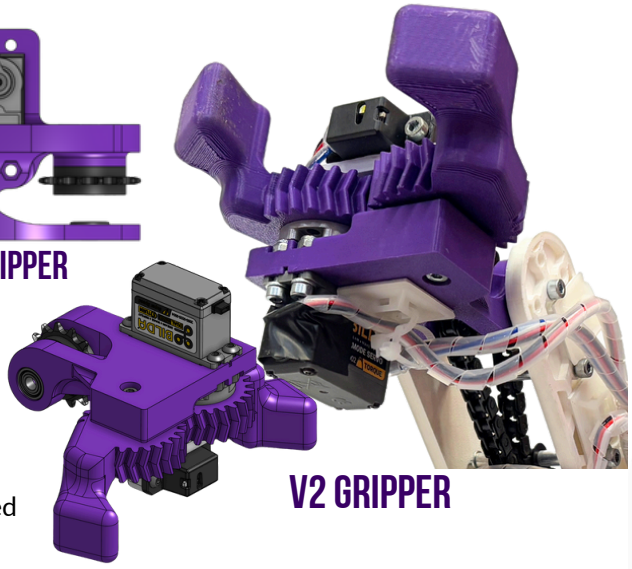
GRIPPER V1 - DECEMBER

- 3D-printed; operated with a servo
- Fixed alignment plate worked with a 1-finger gripper, allowing the robot to move along the wall to grab Specimens
- **Problem:** Samples and Specimens slide out of our control during matches

V1 GRIPPER

GRIPPER V2 - JANUARY ONWARD

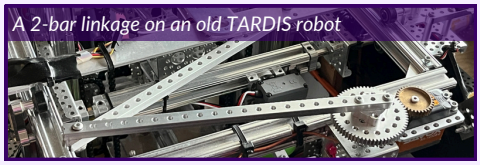
- **Solution:** Iterate a new gripper, with a triangular finger profile that **automatically indexes and orients sample**
- Double herringbone gears are **strong and easy to 3DP**
- More tolerance misalignment when picking up from wall
- Set servo position loosely holds sample and **prevents burnout of servos**
- **Color sensor automatically closes the gripper** when game piece is detected
- **Full compatibility with arm allowed for fast integration**



V2 GRIPPER

HORIZONTAL EXTENSION - "THE EXTENDO"

- **Problem:** Our game strategy dictated our robot's ability to reach across more than half of the submersible's base
- **Solution:** We developed a servo-driven slide-based horizontal extension on which we mount our intake
- After considering our options for driving the extension, we decided that a **reverse 4-bar linkage was optimal**
- This configuration requires little power to extend fully and takes up less space compared to an ordinary 2-bar linkage
- CAD and 3DP allowed **rapid iteration** during prototyping



A 2-bar linkage on an old TARDIS robot

The full extension of our DR4B extendo

Our custom herringbone gear set on the extendo

TWIN REVERSE 4-BAR LINKAGES

Pros:
- Faster
- Less torque needed to operate
- More compact

Cons:
- More complex

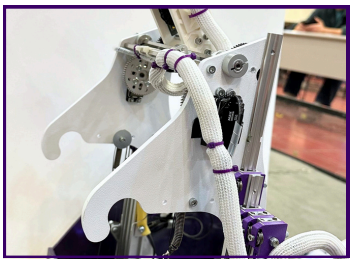
DECISION: USE THE 4-BAR!

VS 2-BAR LINKAGE

Pros: Simple

Cons: Bars would need to be very long to accommo-date desired extension length; longer bars would result in increased torque on the servo, **risking damage to the servo**

WE SHARED OUR EXTENDO MECHANISM ON DISCORD AND HELPED TEAMS AROUND THE WORLD INTEGRATE IT ON THEIR ROBOTS, INCLUDING 20265 HEART ROBOTS IN ROMANIA. THEY THEN SHARED IT IN THEIR REGION, AND EVEN MORE TEAMS ADOPTED IT TO THEIR ROBOTS!



LV. 2 ASCENT MECHANISM

Our **Level 2 Ascent** is achieved with hooks connected to the slides on the lift mechanism

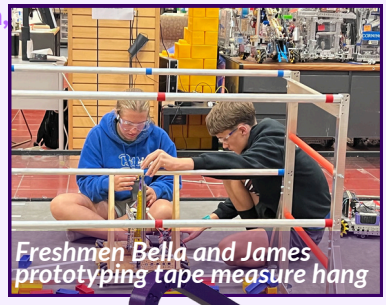
- Enabled through attachment to the continuous lift
- **We used CAD to design and iterate** the angle, pitch and radius of the hooks
- We **3D printed and rapidly iterated the hooks,** integrating them into the "shoulder" of the lift
- We hang from the highest rung because the 'travel' distance to suspend the bot is shorter

COST-BENEFIT ANALYSIS:

DO WE IMPLEMENT 3RD LV. ASCENT?

As part of their learning plan, our first-years had the job of designing and building a 3rd Level Ascent mechanism. It comprised two tape measures mounted on the robot at a 71° angle. Development continued through January, but after an **honest conversation and cost-benefit analysis of our game strategy and needs (at right),** we determined that we would be able to **score more points in cycling Specimens or Samples** than the 30 pts. awarded for a 3rd Level Ascent in same time.

Although we are not using it this year, **we now have valuable knowledge of how to use a tape measure hang** in the event that we can implement it in future seasons!



Freshmen Bella and James prototyping tape measure hang

OUR FINAL LV. 3 DEVICE
We are not using this on the robot

	COST	BENEFIT
IN ENDGAME: CONTINUE SCORING, THEN QUICK LV. 2 @ 4 SEC REMAINING **WE CHOSE THIS PATH**	• Only 15 pts in ascent • More movement around field & opponents • **Risk G427 penalty in Sub during endgame** • Possible frustration of team members who built Lv. 3 subsystem	• Decrease weight & bot complexity • **Repurpose motors to 3rd Gen intake** & lift; decrease intake cycle times by 60%! • **Score more Spec & Samples in final 30 secs;** score more than 30 pts (Lv3)
IN ENDGAME: LV. 2., THEN LV. 3 ASCENT UP THE SUB **WE CHOSE NOT TO DO THIS**	• More complex & heavier robot • **Time consuming to test, debug and integrate** • Cuts into time for Spec & Sample scoring in endgame • Requires precise robot positioning • Only worth 30 pts	• **Gives first-year members ownership of subsystem** • Stand out to other teams for alliance selection • 15pts more than Lv. 2 ascent • First time using design proven by many other teams

$$15\ kg.\ robot \times 175\%\ safety\ factor = 26.25\ kgf\ needed$$

$$2 \times 312\ RPM\ motors = 48.6\ kg.cm\ stall\ torque$$

$$\frac{48.6\ kg.cm\ stall\ torque}{1.75\ cm\ spool\ radius} = 27.77\ kgf\ output$$

$$Continuous\ output\ force \times \frac{1}{\#\ of\ slide\ stages} = cascade\ output\ force$$

$$27.77\ kgf\ output \times \frac{1}{4} = 6.94\ kgf\ output(cascade)$$

$$15\ kg.\ robot \times 175\%\ safety\ factor = 26.25\ kgf\ needed$$

$$3 \times 435\ RPM\ motors = 56.1\ kg.cm\ stall\ torque$$

$$\frac{56.1\ kg.cm\ stall\ torque}{1.75\ cm\ spool\ radius} = 32.06\ kgf\ output$$

$$Continuous\ output\ force \times \frac{1}{\#\ of\ slide\ stages} = cascade\ output\ force$$

$$32.06\ kgf\ output \times \frac{1}{4} = 8.01\ kgf\ output(cascade)$$

$$15\ kg.\ robot \times 175\%\ safety\ factor = 26.25\ kgf\ needed$$

$$3 \times 1150\ RPM\ motors = 23.7\ kg.cm\ stall\ torque$$

$$\frac{23.7\ kg.cm\ stall\ torque}{1.75\ cm\ spool\ radius} = 13.54\ kgf\ output$$

$$Continuous\ output\ force \times \frac{1}{\#\ of\ slide\ stages} = cascade\ output\ force$$

$$13.54\ kgf\ output \times \frac{1}{4} = 3.39\ kgf\ output(cascade)$$

Torque calculations for our lift mechanism

HANG MECH: 2 VS. 3 MOTORS

After analyzing our matches from qualifiers, we knew that our lift/hang mechanism was slow and inefficient. Should we keep two, or move up to three motors?

TWO 312 MOTORS: ✗

Pros:
- Smaller internal footprint; compact
- Simpler gear box

Cons:
- Less torque, speed
- Time to deploy lift & score during matches

THREE 435 MOTORS: ✓

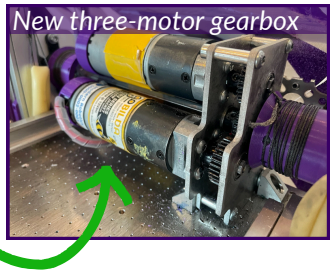
Pros:
- Faster, higher torque
- Decrease cycle times

Cons:
- More complex
- Need to redesign gear box and get it fabricated

THE TORQUE NEEDED TO LIFT A 15KG ROBOT WITH A SAFETY FACTOR OF 175% IS 46 KG CM

OLD: 2 X 312 RPM MOTORS; 48.6 KG CM OUTPUT

NEW: 3 X 435 RPM MOTORS; 56.06 KG CM OUTPUT – INCREASES LIFT SPEED, IT'S 28% FASTER!



New three-motor gearbox

Full extension

TARDIS 5356

We CONTROL:
command-based coding, autonomous strategy, auto preset inputs, odometry

08

OUR CONTROL SYSTEMS: A COMMAND-BASED CODING PARADIGM

After years of **programming into one massive, sometimes disorganized file,** command-based subsystems helps us have a **better structure and hierarchy, and increase programming efficiency.** Each subsystem (ex. arm or gripper) is contained within its own class, which is then referenced in our OpModes or commands. This organization allows the implementation of our TeleOp and Autonomous programs to be **much more streamlined**. This functionality is enabled through the use of an open source library called FTCLib, derived from the FRC variant, WPILib.

Commands serve as a checklist of movements for the robot to complete. This allows our robot to **perform complex, multi-stage automated movements.** Examples include:

- Our intake-to-gripper transfer sequence
- High basket lift and arm position to score (deposit-to-state command) — one-button control

A CHANGE IN ONE PLACE PROPAGATES THROUGHOUT OUR CONTROL SYSTEM, SUPPORTING QUICK ITERATION & DEBUG:

1 EDIT TO THE ARM'S SUBSYSTEM → BASKET AUTO, SPECIMEN AUTO, TELEOP PRESETS

1 EDIT CAN YIELD CHANGES IN DOZENS OF PLACES!

SUBSYSTEM CLASS (ex. gripper)
- hardware declarations
- control logic (ex. PID controllers)
- methods (functions, ex. *closeGripper*)

called in → **COMMANDS**
- sequential or parallel lists of subsystem methods can also list other commands, creating command groups

bound to → **TRIGGERS**
- run commands and command groups through auto & teleop
- can take driver inputs (ex. button) or sensor inputs (ex. color sensors) to run commands

bound to

SEQUENTIAL GROUPS
closeGripper then *waitOneSecond* then *moveArm*

PARALLEL GROUPS
closeGripper and *moveArm*

AUTONOMOUS PRIORITIES & OBJECTIVES

- Consistency: **improved project management** at the start of the season allowed for **more auto development time** before the first competition
- **Collaboration with alliance partners -** with an emphasis on **adaptable timing and parking location**
- **Maximize autonomous scoring late in the season; 5+0 Specimen and 0+5 basket 100% of the time**

OUR AUTO SEQUENCES

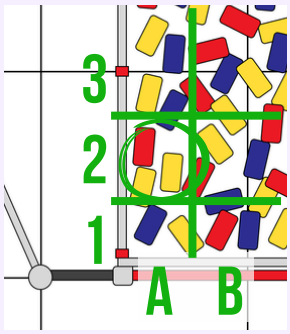
In both, the first step is to detect the color of the preload to be stored for intake automation in the TeleOp period

Specimen auto (53pts):
1. Score preloaded Specimen **(10pts)**
2. Push three Samples on the field into the observation zone while human player converts them to Specimens
3. Score addt'l 4 specimens **(40pts),** park **(3pts)**

Basket side auto (40-48pts):
1. Score preloaded Sample **(8pts)**
2. Pick up and score additional three yellow Samples **(24pts)**
3. Use grid system to pick up & score one or two more Samples **(8 or 16 pts),** park **(3pts)**

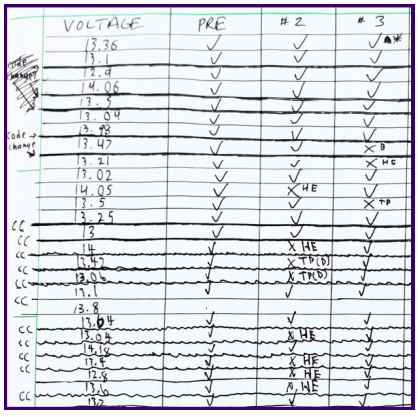
BASKET SIDE BONUS: GETTING A 5TH SAMPLE!

- Before the Auto period begins, **drivers note groupings of Alliance/Yellow Samples in Sub**
- Using a **pre-set coordinate system (see diagram at right) and the joysticks, drivers provide robot input prior to launch on where to "look" for those Samples**
- After 4 samples, the robot goes to position **based on the provided grid coordinates** and **attempts to intake a sample**
- If it doesn't find one quickly, it **moves a few inches to look for another, then scores it**



IF RED ALLIANCE, WE PREFER "A2" FOR THIS RUN!

WHAT IS OUR DATA TELLING US?



Problem: Early in the season, we made changes too quickly and without looking at success data or video evidence when developing auto, **wasting lots of time 'chasing our tails.'**

Solution: We improved our workflow and overall performance by relying on tracking data **(like battery voltage and 5+0 auto program performance, at left)** and reviewing video as a programming team to generate hypotheses and track improvement. **Only with a data mindset have we achieved our auto goals: 5+0+P Spec and 0+5 Sample!**

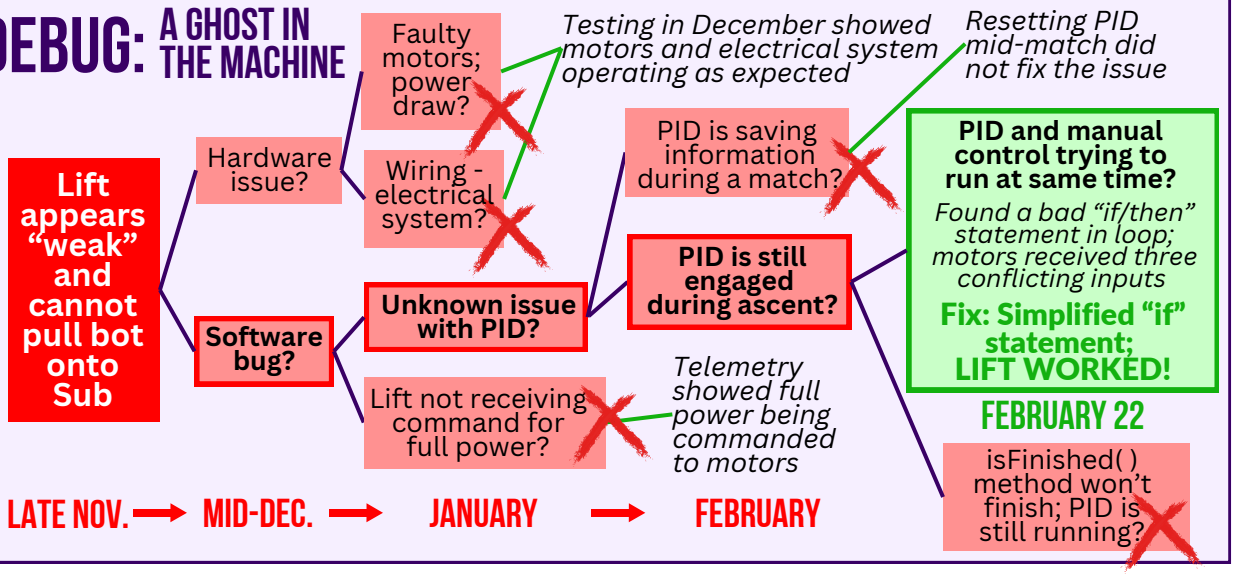
TARDIS 5356

We CONTROL: 09

debug and trouble-shooting, sensors, color automations, reducing human error through automations

SOFTWARE DEBUG: A GHOST IN THE MACHINE

Problem: Around Thanksgiving, we observed our Lv. 2 Ascent was suddenly "underpowered" in practices. Stopping and restarting our program would treat the issue, but was not a real solution. **Our programming coach helped us develop this hypothesis tree to document how we solved the issue:**



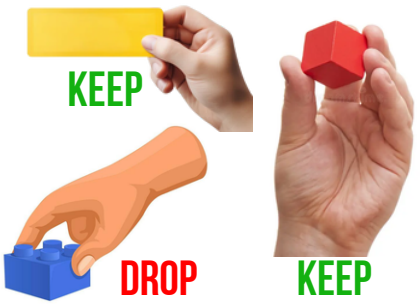
HARDWARE & SOFTWARE CONTROL COMPONENTS ON ECHO

- **3 goBILDA odometry pods** enable us to **record our position on the field using odometry,** run using RoadRunner code, **helping us to program Autonomous efficiently**
- **1 REV Magnetic Limit Switch** **prevents the slides from back driving** and **indexes the slides'** bottom position
- **1 Integrated Motor Encoder** is used to calculate the **position of the lift** and fed back into a PID loop to **prevent overdriving the lift**
- **3 REV V3 Color Sensors** used to detect if we have a **sample of the right alliance color** in our intake; on the arm to detect **if there is a specimen present;** one in the jig to ensure the sample is fully inside the jig to **initiate the transfer**

SAMPLE COLOR VERIFICATION

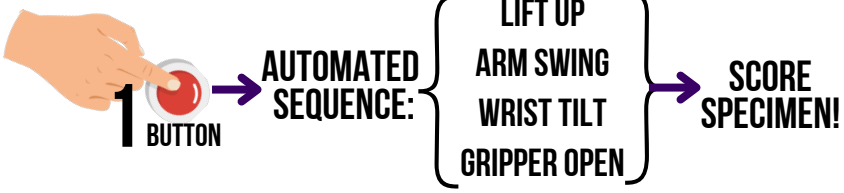
We have a color sensor in our intake to verify the sample color. If the sample color **does not match the stored alliance color, it is immediately & automatically ejected from the robot's intake.** This allows the robot to make fast, independent color decisions so our drivers can focus on driving during sample intake.

IMAGINE WE'RE ON THE RED ALLIANCE. THE ROBOT KNOWS TO...



CONTROLLER PRESETS: REDUCE HUMAN ERROR, IMPROVE DRIVABILITY

- With **low clearance between parts, automation ensures precise movements** to help avoid interference in our hardware
- **To reduce human error, 6 preset positions coordinate the actions of these elements** during the driver-controlled period: intake, arm, gripper, extendo, lift, **streamlining our gameplay (see below!)**
- Color sensor will **automatically close the gripper** when a sample or specimen is detected, respectively
  - The bot automatically stops the intake to **prevent over-possession and penalty** when the color sensor in intake detects incorrect alliance color



TOP 3 LESSONS LEARNED

1. **Divide and conquer:** We delegated programs – subsystems, Teleop, Basket Auto, and Specimen Auto – to **maximize time and programmers' focus.** This strategy allowed us to finish all three within a week of one another and tune, then test & debug.
2. **Commenting in the code** improves collaboration between team members and decreases confusion. **We also code on a large-screen TV** so our mentors can monitor and support us, when needed.
3. **One thing at a time:** After **early errors, mistakes and inefficiency,** we re-commited to a methodical **"observe, talk, hypothesize, edit, test" workflow** where we focus on **one variable or change at a time** to prevent inefficient iteration and silly mistakes.

HOSTING COMPETITIONS:
FLL AND FTC CORNING QUALIFIERS

TARDIS hosted the Corning FLL Qualifier on January 18 and the FTC Corning Qualifier on February 9:

FLL:

- Build 4x Mission Models
- Set up tournament venue
- Queue 13 teams to judging rooms and matches
- Reset tables after matches
- Live stream tournament
- Run robot driving demos for FLL students and families
- **Give 15-minute presentation about FIRST and our journey to Worlds 2024**

FTC:

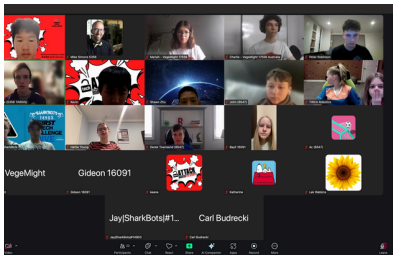
- Set up and tear down the competition venue
- Queue 17 teams to judging rooms and matches
- Coordinate field resetters & student photojournalists to document the day
- Livestream the event on YouTube
- **Run a "STEM Commons" for youth and family members, including demo robot driving, hands-on flying drone demos, and other STEM activities**
- Hand out tools, spare parts, and provide "Robot FIRST Aid" in the Pits
- Provide a "Thank You" board, inviting teams to appreciate coaches & mentors

GRACIOUSLY PROFESSIONAL, AND A LITTLE HUNGRY

As a veteran team, TARDIS has a reputation for overpacking for competitions; regional staff and coaches seek us out, knowing of our abilities to help other teams on game day. **We live out Gracious Professionalism in helping all teams to have a shot at competing, and learning from one another — even if it means we go a little hungry.** At one of our January competitions, **Dean skipped lunch and helped 11975 (right) install four new motors on their drivetrain.**

We have also given other teams motors, upgraded a team's plastic chain to metal to help them hang in endgame, improved one team's wire management, and gave multiple teams power switch stickers to help them pass inspection.

ASK A WINNER WEBINAR



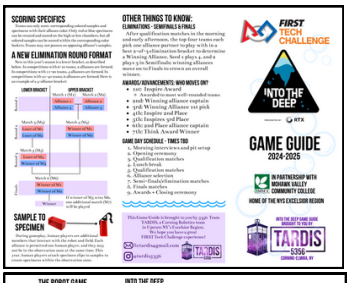
Team 22471 techATTACK reached out us and invited us to join their webinar. We and teams including the FTC World Champions presented our journey to the FIRST Championship last year and how our seasons are going this year. We were able to **share what it meant to be a student-led team and how we navigated the various iterations of our intake subsystem. We learned about other teams' cultures and work habits, sustainability and recruiting methods, and custom-pathing algorithms.**

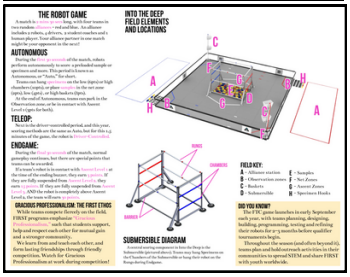
INTO THE DEEP - GAME GUIDE
IMPROVING THE AUDIENCE EXPERIENCE

We know that teams' family members and other audience members enjoy watching our matches, but **we often hear complaints that they don't understand the game.**

Therefore, this is our second year **creating a trifold "Game Guide"** for Into the Deep to improve audience understanding.

We **are distributing copies at today's competition**, and have had tremendous success distributing them at qualifiers throughout our region – **we distributed at least 100 copies at every qualifier we attended,** and shared with every tournament director in our region for the others!





FLL OUTREACH

This year, several of our team members helped Severn Robotics, a rookie FLL team that started at an elementary school after visited last year! We helped them by:

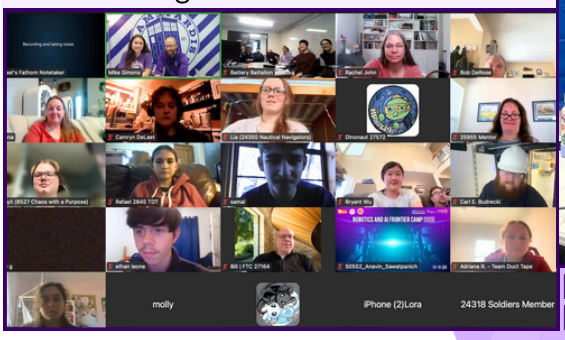
- Building LEGO mission models for their game
- **Teaching simple mechanisms and common types of LEGO robots and designs**
- Brainstorming with interview questions for their STEM project about marine biology
- Discussing strategy and how to think about solving missions in the game.

RoboRoadrunners were able to score 225 points at the Corning FLL Qualifier, and won the Breakthrough Award and Coaches Award!

OUR TEAM-TO-TEAM OUTREACH: TARDIS GOES GLOBAL!

PORTFOLIO SEMINARS

We were #2 Think Award winners at FIRST Worlds in April 2024. After our documentation coach posted our portfolio on Facebook, several teams reached out to us for advice on their portfolios. **We hosted more than 90 teams in a Zoom webinar on January 19 to share our workflow** and experiences in documentation with teams from California, Brazil, & beyond; an additional 500+ viewers caught the webinar on YouTube!



SOME OF OUR WEBINAR'S 90+ ATTENDEES

MECHANICAL

We shared our extendo design on the worldwide FTC Discord. Afterwards, several teams reached out to us for help with their designs; **Heart of RoBots in Romania used our design on their robot!**

NICOLE & COACH MIKE HOSTING THE TRAINING

GAMEDAY & MORE!

We met with 2 rookie teams from China to advise them on what to expect at competition, how to prepare for it, and how to strategize the game — all in Mandarin! **They spread the word and 32 MORE Chinese teams joined us for a portfolio workshop in Mandarin three weeks ago!**

CHINESE TEAMS

15534 19789
16093 19859
16107 19964
19392 19965
19577 21981
19585 24005
19660 24068
19661 24393
19663 24551
19665 24567
19666 24599
19675 25787
19705 26167
19725 26296
19726 26910
19730 28001
19759

One-on-One Feedback:

Our doc lead, Nicole, offered eight 1:1 Zoom and written critiques of other teams' portfolios this winter, giving page-by-page feedback and design tips to grateful teams!

25483 20265 25109

27572

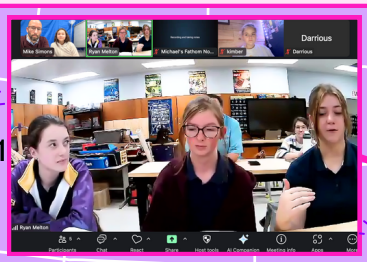
TECHDIVAS (NIGERIA) WITH PARTS WE DONATED AFTER MEETING THEM AT WORLDS 2024

20858 18763

27373 17556 6955 27364 6567 26453 17222 7486 8699 5485 12736 8663 7486 25707 8397 27186 24350 7420 25687 8527 14281 19411 25609 27334 27445 26446 27164 23517 22311 13270 24318 23669

7198 8934 24130 17595 23270 18108

WE GAVE 26446 ROGO ROSE, A ROOKIE TEAM, FEEDBACK ON THEIR PORTFOLIO ON JAN. 7. THEY WON THE THINK AWARD THE FOLLOWING WEEKEND!



JAN. 9 ZOOM WITH 11279 PURE IMAGINATION TO GIVE FEEDBACK ON THEIR PORTFOLIO

8513 6294 23588 19940 13999 23587 23554 26986 12890 13702 16523 20245 25650 14382 17596 20201 27457 26446 14903 26986 27239

12649 22526 14596 26448 9034 21333 26980 23493 21623 26395 23307 25655 6547 5155 14628 23926 14291 21457 23695 23521 14750 23509

22471 25961 27120 23224 23696 18340 21463 16901 65768 23441 23676 6016

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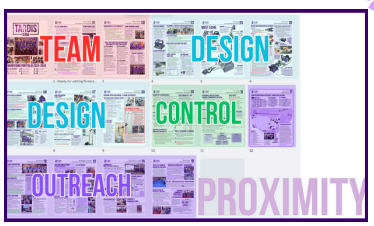
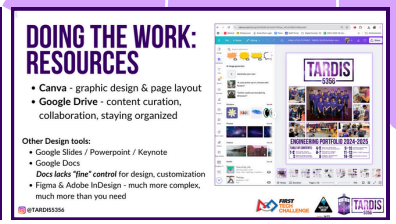




SLIDES FROM OUR PORTFOLIO WEBINAR - JAN. 19, 2025

HILLIARD CORPORATION

On May 24th, TARDIS visited Hilliard, a motion control, filtration product, and braking system manufacturer in Elmira, NY:

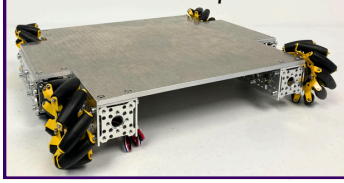
- We learned about their processes and products, including their filter assembly line and the ways they use **automation on their lines to reduce human error**
- We made a presentation about FIRST, last season and our Worlds' experience to their employees

Outcomes: We asked Hilliard's CEO and engineering lead for assistance machining a "shower drain"-style aluminum chassis deck plate, which they did!

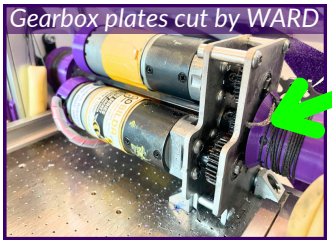
Learning about Hilliard's units

TARDIS at Adaptec in Erwin, NY

Our drive train with Hilliard's custom-machined plate



Gearbox plates cut by WARD



OUR STEM OUTREACH VISITS HELPED US LEARN ABOUT CAREERS AND HOW OUR TEAM'S WORK CONNECTS TO INDUSTRY, AND OPENED THE OPPORTUNITY TO HAVE LOCAL FIRMS SUPPORT OUR JOURNEY, FABRICATING PARTS WE CREATED IN CAD!

WARD APPARATUS

TARDIS has continued a 3-year relationship with a local emergency vehicle manufacturing company, headquartered across the street from our robot club, where we have:

- Learned about the process of designing and manufacturing custom parts, from the raw materials to the finished product
- Learned about **wiring and cable management best practices that we used both last and this season**
- Had their support in fabricating more than a dozen custom parts between this and last season

Outcomes: Ongoing relationship with WARD leadership led to the donation of 7 custom water-jetted parts this season and direct instruction in best practices for wiring and electrical systems management, which has streamlined our wiring mapping & management!

ADAPTEC SOLUTIONS

On Sept. 16th, TARDIS visited Adaptec Solutions, a company specializing in automation and material handling:

- Learned about automation, their facility, manufacturing cells, **designing grippers for jumbled products/inventory** in industry, computer vision and object recognition systems, fabrication, and overall careers in design and manufacturing
- Presented FIRST Tech Challenge, our Centerstage season and our gripper design ideas for Into the Deep

Outcomes: Received input and insight early in the season about different gripper designs to handle this year's game pieces, similar to how Adaptec handles "jumbled" parts in assembly

UPSILON ROBOTICS

One of our mentors, **TARDIS alumnus Will Boychuck,** founded the company **Upsilon Robotics.** He presented his patented system on Nov. 10th, a **robot that can maneuver around a sharp 90°, 8" pipe** – the only of its kind! Robots like this can carry x-ray and other sensing payloads to look for microfractures and other issues in industrial settings.

- Will presented about his design process and subassemblies
- Some of our team members were involved in the design, fabrication and construction of the prototype robot
- Used some GoBilda parts because he was familiar with them, showing us how much can be done with them!

CORNING INC. - LASER CUTTING LAB

On Oct. 14th, TARDIS visited our programming coach, Mr. Piech, at Corning Incorporated. The company is our primary sponsor and a Fortune-500 glass manufacturer.

- We learned about his lab's laser-based glass cutting machine and how it helps other departments develop proof of concept and prototype techniques on the small scale before implementation at scale in manufacturing
- Mr. Piech shared how programming and machinery are used to increase repeatability and accuracy in systems and manufacturing

We were glad to connect with our sponsor and coach to learn more about what they do.

Sullivan Park, Corning Incorporated's research and development facility in Erwin, NY; home of its laser development lab

CAMP TARDIS: A STRONG FUTURE FOR FTC

We hosted our fourth annual 3-day Robotics camp at Corning-Painted Post High School over midwinter's break — it was a huge success!

- Introduced 7th and 8th graders to FIRST Tech Challenge
- Ran three design challenge activities: building earthquake-resistant towers, card towers, blindfolded puzzles, and rubber band/balloon-powered cars
- Taught campers about the importance of communication and Gracious Professionalism in FIRST
- Coached campers while driving our demo bots
- Campers assembled simple FTC drive trains, programmed TeleOp functions on our demo bots with Java, and learned about robots in medicine and modeled prosthetic hands
- We welcomed parents on the final day and share opportunities for enrollment in FIRST programs in our club

54% of our campers were female this year — our highest percentage ever!

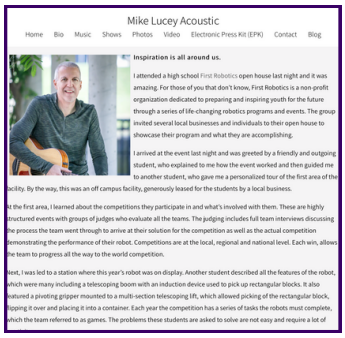
Outcomes: 20 of the 50 campers who attended in the past 3 years joined FTC teams, fulfilling our sustainability needs — 7 of our current team members are Camp TARDIS alumni!

NOW YOU COME VISIT US: STEM PROS OPEN HOUSE

After visiting local robotics and manufacturing businesses this year, and to help strengthen connections with our local STEM community, **we held an open house at our facility on Feb. 20, hosting ten STEM Professional guests from five different companies.** We shared:

- FIRST Tech Challenge, season flow and this season's game, robot, CAD, competition day structure, and more!
- Toured them around OUR workspace

We received incredibly positive and encouraging feedback, and the next day, Mike Lucey, the Director of Application Engineering from Adaptec Solutions posted on his blog about how impressed he was by our team!



Mike Lucey Acoustic

Home Bio Music Shows Photos Video Electronic Press Kit (EPK) Contact Blog

Inspiration is all around us.

I attended a high school First Robotics open house last night and it was amazing. For those of you that don't know, First Robotics is a non-profit organization dedicated to preparing and inspiring youth for the future through a series of life-changing robotics programs and events. The group invited several local businesses and individuals to their open house to showcase their program and what they are accomplishing.

I arrived at the event last night and was greeted by a friendly and outgoing student, who explained to me how the event worked and then guided me to another student, who gave me a personalized tour of the first area of the facility. By the way, this was an off campus facility, generously leased for the students by a local business.

At the first area, I learned about the competitions they participate in and what's involved with them. These are highly structured events with groups of judges who evaluate all the teams. The judging includes full team interviews discussing the process the team went through to arrive at their solution for the competition as well as the actual competition demonstrating the performance of their robot. Competitions are at the local, regional and national level. Each win, allows the team to progress all the way to the world competition.

Next, I was led to a station where this year's robot was on display. Another student described all the features of the robot. Which were many including a telescoping boom with an induction device used to pick up rectangular blocks. It also featured a pivoting gripper mounted to a multi-section telescoping lift, which allowed picking of the rectangular block, flipping it over and placing it into a container. Each year the competition has a series of tasks the robots must complete, which the team referred to as games. The problems these students are asked to solve are not easy and require a lot of

WANT TO USE MY BASEMENT?

Mr. Matt Towner, owner of iCode Corning, attended our STEM Open House. **On the spot, he offered his business' basement to house a new FTC team we are founding in May 2025!** We were able to visit his facility on Feb. 25th to gauge if it would be appropriate to hold an FTC team – it is perfect!

PROJECT 29K: GROWING FIRST IN OUR COMMUNITY

Problem: We have an abundance of FLL teams (more than 16) and many 8th graders interested in joining FTC teams but **not enough local teams to place them in.**

Solution:

Start our area's first new FTC team in six years!

We care about sustainability in our area and the Excelsior Region as a whole, not just for our team.

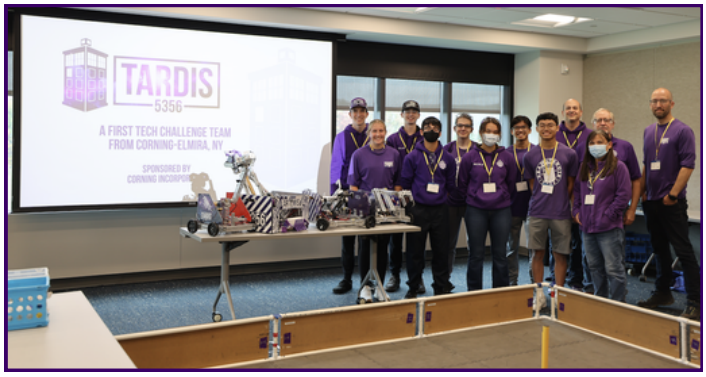
"Project 29K" is our name for the effort to found a new FTC team in May 2025. (Rookie teams are now receiving numbers in the 29XXX range.) **We have already secured a verbal commitment for a space to house the team 20 minutes from us;** the owner has asked us to draw up a lease agreement with no cost attached.

Additionally, we have prepared an initial budget for two years of operation, estimated at $10,000, and have **asked companies that attended our STEM Open House to come aboard as founding sponsors for Project 29K.** This week, we are **actively seeking mentors** with STEM backgrounds — we plan to train P29K team members with our first-year members from May through August!

CORNING INC. - BRING YOUR CHILD TO WORK DAY

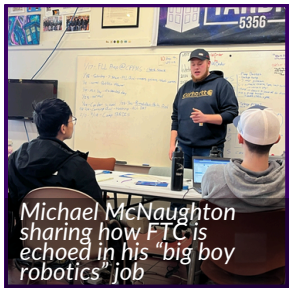
TARDIS visited Corning Incorporated for Bring Your Child to Work Day, for the first time since COVID-19 broke out:

- Hosted a robotics program at Corning's Sullivan Park facility
- **Shared a presentation about FIRST and our World's journey** to 20+ kids and employees across three sessions
- **Students drove our three demo bots** and learned about the building and programming processes that went into the robot



OUR ALUMNI: FTC LESSONS

We are thankful to be able to stay connected with our alumni, who visit us multiple times a year. We have had two formal visits from Peter Dohn, a founding member of Team TARDIS and current NASA engineer, and Michael McNaughton, a college student and employee of the Haas Factory Outlet, a division of NYMAT Machine Tool Corp. From them, **we have learned the importance of listening to our coaches and mentors: their advice about workflow, troubleshooting, and task management are what we will experience in our future job sites and beyond!** They also provide us with important feedback and guidance in our interviews & portfolio.



Michael McNaughton sharing how FTC is echoed in his "big boy robotics" job


Peter Dohn presenting about the Artemis SLS program in Nov. 2024

COMMUNITY CONVERSATIONS


Team TARDIS Update 02/02 - a BIG one!

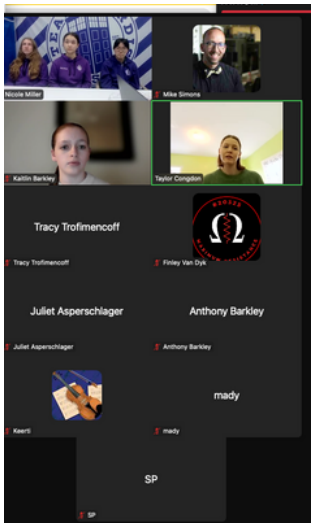
A SCREENSHOT OF ONE OF OUR EMAIL BLAST UPDATES

Team TARDIS sends **bi-weekly email updates to 230 STEM professionals, educators, and alumni** to update them about the team, our robot's development, and our outreach in the 2025 Into the Deep season. This outreach to possible advisors, mentors, and STEM professionals is part of our ongoing sustainability plan, as we keep communication lines open to professionals and make FIRST loud in our community!

We have gained more than a dozen FLL & FTC judge & referee volunteers this way – we can't do it without them!

STEMINISTS: EMPOWERING FEMALE VOICES IN FIRST

When hosting the Corning Qualifier, our team was approached by another team's coach. He asked us **how the girls on our team were able to be heard.** Turns out, the only girl on his 10-person team was **being pushed away from doing any tasks regarding the robot** (programming and building). Although we were able to meet her and give her emotional support, we began to wonder: **What can WE DO to help other girls in FIRST facing similar situations? On March 30th, we hosted a 1-hour webinar with 2 female professionals in STEM fields and 9 attendees.** Our panelists shared their workplace inequality experiences, how they navigated them, and answered various inequality-based questions to help girls and coaches begin to create a welcoming work and learning environment for girls on their team. We hope to continue efforts to support girls in FIRST.

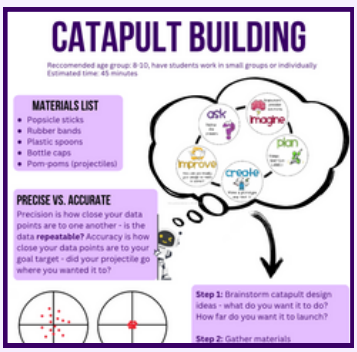


STEM ACTIVITY & STORY BOXES

THE NEXT PHASE OF OUR SCHOOLS PROJECT

Over the past 3 years, we have **expanded our relationship with the elementary schools in our area,** visiting 5 schools, spreading STEM and robotics to the students and teachers. To continue the students' growth, **we secured a $600 grant from Silicon Carbide,** a local manufacturer, and compiled a collection of kid-friendly STEM books (see below), and created a workbook of engineering design activities all packaged in a plastic tote — **each school we've visited is getting a STEM Activity box in March 2025 for teachers to use in class!**

STEM box storybooks



STEM Activities, in a binder in each box

TARDIS 5356

We INSPIRE: youth outreach, egg drop, robot driving demonstrations, mental health, philanthropy, high school engineering class **15**

AN EGG-STRAORDINARY OPPORTUNITY FOR FUN!

TARDIS **assisted the Society of Women Engineers (SWE)** in their annual egg drop, where we volunteered with helping drop the egg capsules, distributing prizes, and even serving as emcee!

In addition, we set up a field and demo robots, and **70 egg drop participants** got the opportunity to drive our demo robots. Then, **SWE hosted a station at our Feb. 9 FTC Qualifier's "STEM Commons,"** our activity area for youth at the competition!

KIDS AT PLAY: WINFIELD + JUNETEENTH

We continued our yearly visits to **Winfield Elementary School,** who reached out to us about hosting robot demos at their Spring Fun Fair and Fall Open House, where we engaged with **200+ students and families** each visit, providing them with a chance to drive our robots and **learn about STEM and FIRST.** We brought the **same demo to 50 students at Carder Elementary's STEM night in February,** and will again on March 20 at Horseheads Intermediate School!

We also continued our outdoor demo at the **Elmira Juneteenth Festival,** where we have engaged with **280+ attendees** in the past two years, including students in STELA – a local FLL club for students in under-served communities.

DEF.INIT - SUPPORTING OUR PEERS' CODING PROGRAM

TARDIS participates in the annual FLXGives fundraiser, a 24-hour fundraiser for non-profit organizations in the region. This year, we supported both the Corning Community Food Pantry and Def.Init, an organization run by the Corning-Painted Post High School Coding Club. **We were able to raise $536 for the students to purchase Arduino boards – miniature computer kits – to teach middle schoolers to code.**

MENTAL HEALTH: HOW ARE YOU... RIGHT NOW?

TARDIS **prioritizes conversations around team members' mental health.** To enable these conversations, one of our mentors' grief counselor, **Heather Morey,** has visited roughly every three months to speak with the team and our parents about various topics:

- Balancing school, robotics, sports and social life
- Where and how to find help
- How to check on one another

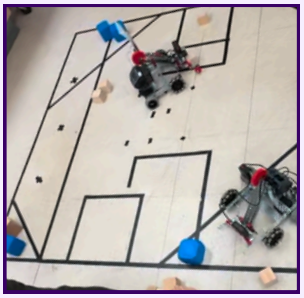
We realize that our team members are people outside of robotics, and often busy. Our goal is to **create a positive learning environment** to promote individual growth, increase team bonds, and ensure an encouraging work environment.

A TEAM & FAMILY MEETING WITH THERAPIST HEATHER MOREY TO BEGIN THE SEASON

WE'VE GOT GAME: BRINGING THE FTC MINDSET TO CPP HIGH SCHOOL'S CLASSROOMS

A teacher at our local high school has a Vex Robotics class and **needed help hosting a competition for his students**. One of our team members, Victor, was **able to create a FTC-style game for the class** inspired by the Freight Frenzy season. Here's how it worked:

- Autonomous (using block code): retrieve blocks from the center of the field and park
- TeleOp: Similar gameplay, with more game elements being introduced by human player
- larger blocks worth more points
- stacked blocks worth more points
- Endgame: a rubber duck is introduced to be scored



This experience gave Victor the opportunity to share FIRST Tech Challenge and his journey with TARDIS with classmates at school!

CORNING COMMUNITY FOOD PANTRY: A LASTING PARTNERSHIP TO HELP NEIGHBORS IN NEED

TARDIS is proud to have been able to **expand our relationship** with the Corning Community Food Pantry throughout the past 4 years. We raised $1,870 during FLXGives '2024; our 4-year total is **$9,249**, feeding **5,640 PEOPLE** for Thanksgiving!