CRASH 6837

CANNON SCHOOL

CODING, ROBOTICS, AUTOMATION, AND SCRIPTING HERD

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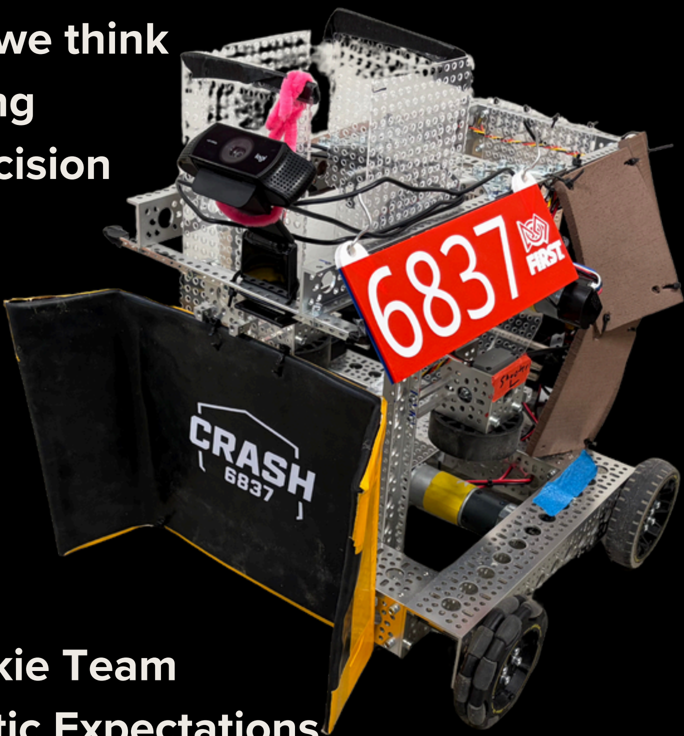


ABOUT US

We are Team 6837: Cannon C.R.A.S.H. (Coding, Robotics, Automation & Scripting Herd)—a rookie FTC team. Our name embodies our core belief: the most powerful learning happens when something breaks and we must rebuild it better than before. We are a group that values resilience, iteration, and growth through challenge. Our team proudly "CRASH-es out" at the end of every meeting, celebrating both our efforts and the lessons learned along the way.

In our first year, we've quickly discovered that robotics is a dynamic mix of building, coding, testing, failing, debugging, and—often—laughing together when things don't go as planned, right up until the moment they finally do. We meet weekly on Mondays from 4:30 to 7:00 PM, with additional practice sessions and virtual meetings scheduled as competition deadlines approach.

Together, we are more than a new team—we are a learning community built on curiosity, collaboration, and the courage to crash, rebuild, and succeed.

Mush Hughes

Coach

9 yrs of experience as Makerspace Facilitator

BA in Music Education & Music Business and M.S.Ed. in Educational Technology from The Crane School of Music at the State University of New York at Potsdam

Dr. Jeremy Jay

Mentor

programming and automation efforts

25 yrs of experience: software & robotics

PhD in computer science

director of software engineering

Eric Ruddy

Coach

14 yrs of experience as Instructional Technologist and Makerspace Teacher

BS in Elementary Education from UNCC

Dr. Beth Smith

Mentor

hardware design & systems thinking

18 yrs of experience across government & commercial engineering projects

PhD in mechanical engineering & PMP certification

We are fortunate to have strong leadership and expert guidance. Our coaches, Mush Hughes and Eric Ruddy, keep us organized, motivated, and focused. Additionally, we are supported by two dedicated engineering mentors. , creating an environment where we are encouraged to try ideas, learn from mistakes, and continuously improve.

MEET THE TEAM

Name Class Of	Area of Expertise	Goals to Improve	Fun Fact
Hannah '27	Design, Engineering, and Building	I want to move from being able to build to being able to independently design a system from CAD ⟶ prototyping ⟶ testing. Specifically improving my CAD skills.	I have visited 3 countries in the last 6 weeks.
Emma '27	Engineering and Building	I want to work on learning how to build a robot with modifications based on set goal without a specific set of instructions.	My first name has the same number of letters as my last name.
Sarthak '27	Engineering and Building	Truly understand the engineering process and begin planning out processes.	I like only the grape Jolly Ranchers.
Nina '27	Engineering and Coding	My main goal is to get more involved in te engineering aspect of my team. As of right now, my main focus as been coding.	I get starbucks before practice everyday.
Adam '29	Engineering and Building	I want to get better at working with the robot. Both by learning new skills and improving the ones I have. That includes building, coding, and iterating.	I have lived in 3 continents.
Jonas '29	Driving And Coding	Get better at Java coding.	I like drift competitions.
Mathew '29	Engineering and Coding	Getting a deeper understanding of Java.	I own a famous wrestler's shoes.

PRACTICES AND DECISION-MAKING

Practice Structure

- Split into build, programming and miscellaneous groups
- Frequent check-ins to share progress and collaborate
- 2 drive teams so that more of us can gain experience

How We Make Decisions

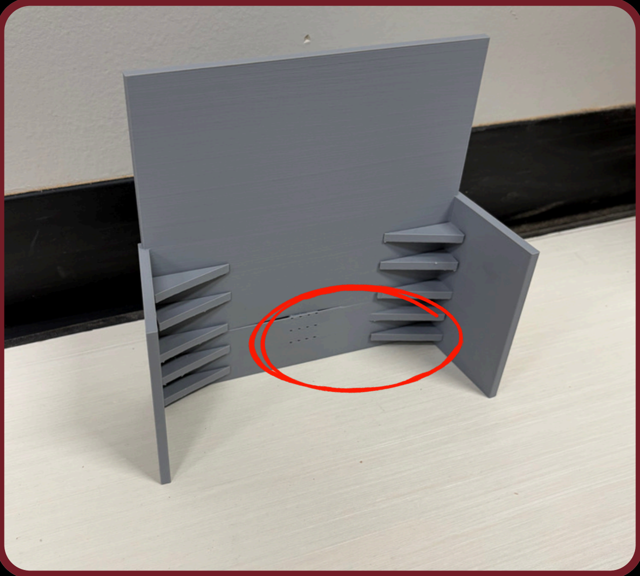
- Ideas are shared openly
- We divide tasks based on ability and availability.
- Each task or project is assigned a team of 2-3 people.

LEARNING THROUGH FAILURE

Examples:

- Chains snapping under torque (oops!)
- 3D prints cracking
- Shooter inconsistency

When something failed, we had group discussions to help us improve our process, become more confident, and work better as a team.



KEY ACCOMPLISHMENTS

- Launched our rookie FTC team!!
- Recruited new members and built a positive team culture

- Designed and built our first robot chassis
- Created a working launcher system
- Added a functional snowplow mechanism (our version of an intake)
- Began transitioning to a second-iteration robot (H-Bot)

- Presented robotics to our entire high school school community
- Aided the FLL teams at our school

ENGINEERING PROCESS

ENGINEERING APPROACH: HOW WE THINK

- As a rookie team, we knew we would have to prioritize rather than attempt to do everything
- We started by deciding what systems mattered most
  - Drive train reliability
  - Launching game pieces
  - Basic autonomous mode
- We intentionally avoided overly complex features like raising our bot for end game
  - These features would stretch our time and experience too far
- This helped us build a robot that works consistently, rather than an elaborate, unexecuted design

BRAINSTORMING AND PROTOTYPING

After Brainstorming

- Sketch ideas on whiteboards/paper
- Write down notes explaining how each idea might work
  - We compare ideas using pros and cons lists
  - Choose designs that seem both effective and realistic for our skill level

Our prototypes are also intentionally fast and simple. We used cardboard to test ideas quickly and learn without worrying about perfection. Our goal at this stage is learning quickly, not building a final product.

We also look for inspiration from previous FTC robots, online videos, and real-world machines. By researching, we saw what worked, and ways to avoid possible mistakes.

USING NUMBERS TO MAKE DECISIONS

As the season progressed, we learned that guessing was not enough

- We began using more measurements and data to guide decisions

Our shooter system could not shoot the ball, though it mechanically looked fine

- To investigate this, we
  - Used a video-based tachometer and estimated wheel RPM using video frame rates
- We discovered that the motor was not running at its intended speed, and reset it to the factory specs, the shots consistently improved. #RookieTeam

We compared closed-loop and open-loop control and chose the approach that best matched our reliability goals for this season.

MANAGING RISK AND RELIABILITY

Major Issues:

- Plastic chain snapping in high-torque situations (aka when we tried to drive)
    - Based on testing, we Replaced the plastic chain with a metal one
        - Saw a large improvement in durability and reliability.
- Incapable of shooting from distance.
    - Designed diverter that would change the launch angle allowing us to shoot from up to 5 feet away.
- Autonomous mode was incapable of detecting which starting position we are in.
    - Built a switch that would change the autonomous behavoir, depending on alliance color and starting position.

WHAT THIS PROCESS TAUGHT US

We learned that every part of the robot needs a clear reason to exist. We also learned that material choice, precise assembly, and accurate measurement are just as important as creative ideas.

Overall, our engineering process helped us move from guessing to testing, from rushing to planning, and from fixing problems randomly to fixing them intentionally.

This process also informed the design of our second-iteration robot (H-Bot), which we began developing to address limitations we identified in our first build.
All of these decisions and lessons directly shaped the robot we brought to competition

ROBOT OVERVIEW

This robot represents our first complete build as a rookie team and reflects the design priorities we set early in the season.
The primary goals of this robot are to shoot game elements with consistency and operate predictably under driver control and in autonomous mode.

DESIGN TRADE-OFFS AS A ROOKIE TEAM

As a rookie team, we quickly realized that trying to excel at every part of the game was unrealistic. Instead, we made intentional trade-offs, and maximized the efficiency of certain aspects of our robot. For example, while an active intake system could have improved scoring efficiency, adding it to our existing robot would have required major redesign late in the season. Rather than risking reliability, we chose to focus on improving ball redirection and shooter consistency using simpler mechanisms: Diverter

VERSION II : "H- BOT"

In addition to our competition robot, we began development on a second-iteration robot known as H-Bot. H-Bot was created to address the issues we encountered with the starter bot: mobility, the lack of an active intake system, and increasing the shooting distance. We addressed these issues by implementing Meckanum wheels and designing an active intake system. We later used this robot to scrimmage against ourselves and practice against a defending robot.

DIVERTER

After our first competition, we noticed we were getting easily defended because our robot had a restricted shooting range. To combat this, we decided to build a diverter to change the angle our robot was shooting out balls to increase shooting range.

With our experience in physics and calculus, we applied kinematics equations, to derive an equation that would give the angle.

$$y(x) = x\tan\theta - \frac{gx^2}{2v_0^2\cos^2\theta}$$

Then, we set the derivative of dx/dΘ = 0 to find the most optimal angle that would have the most shooting ranges.

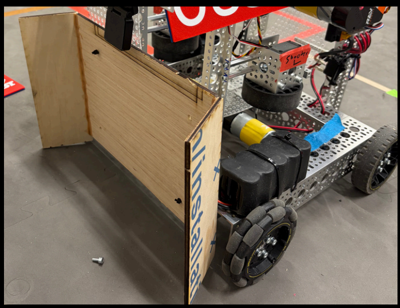
$$\frac{d}{d\theta}\left[\frac{v_0\cos\theta}{g}\left(v_0\sin\theta + \sqrt{v_0^2\sin^2\theta - 2gy}\right)\right] = 0$$

SNOWPLOW MECHANISM

One of our most important design iterations was the development of our “snowplow” mechanism. Early in the season, we noticed that game elements were difficult to return to the loading area because our robot did not have an active intake system.

Brainstormed Ideas

- passive intake
- active intake
- a simple snowplow



The wooden version that snapped ←

Options	Pros	Cons	Descision
Passive intake	Simple	Inconsistent	Rejected
Active Intake	Controlled and effective	Time consuming and would require bot redesign	Rejected (for this bot due to time constraints)
Snowplow	Pushes pieces for simple reloading	Requires human reloading	Selected

THE PROCESS

Our first snowplow prototype was 3D printed, but it cracked due to low infill density and was not wide enough to be effective. We also ran into size constraints caused by a large crossbar at the front of the robot. To solve this, we replaced the crossbar with a smaller metal piece, which reduced the robot’s length and gave us more usable space.

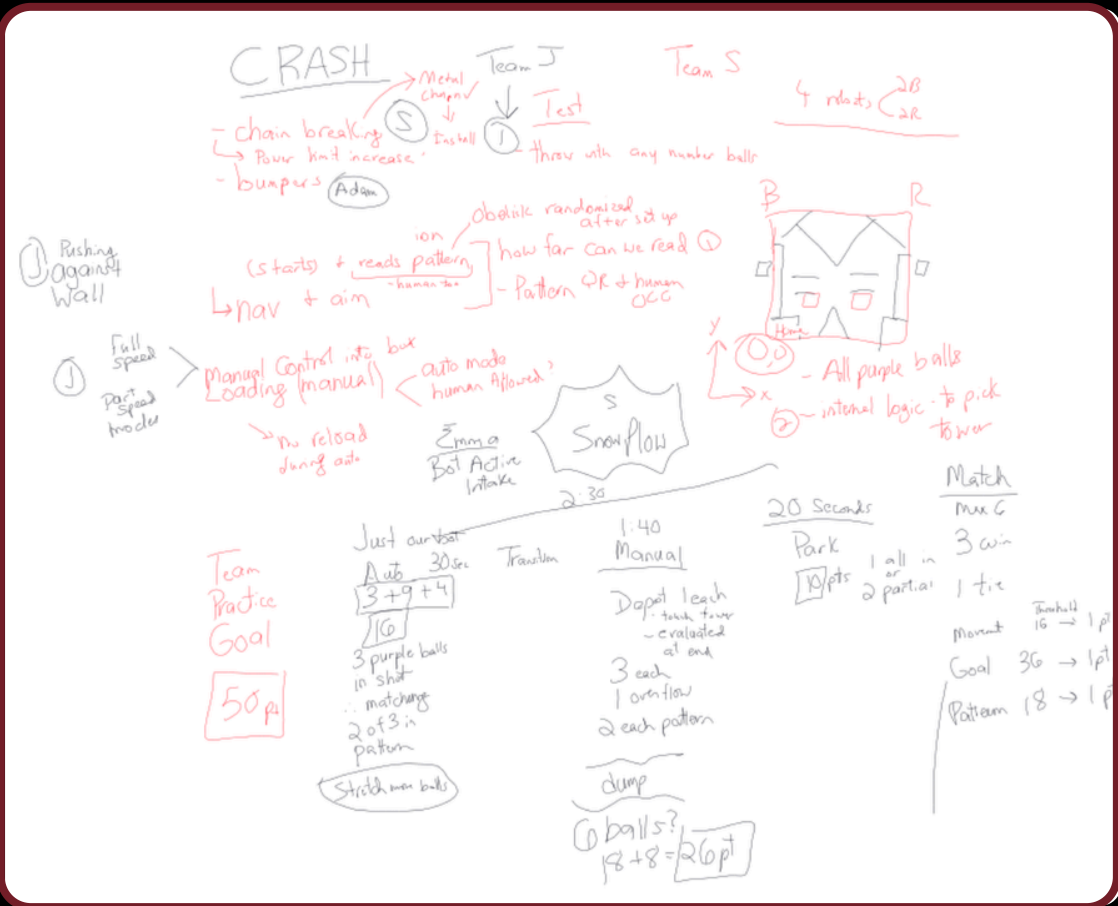
After multiple failed prints and material tests, we decided that laser-cut wood would be sturdier and easier to manufacture. Using improved dimensions based on earlier models, we created a wooden snowplow that performed much more consistently during testing. This wooden design eventually snapped under the pressure in the week before our first competition. We decided to triage and rebuild the design using the same dimensions instead using aluminum sheet metal. We bent and hammered the sheet into our desired shape before wrapping it in a sheet of rubber to prevent bending, and to adhere to the regulations around sharp objects.

SCORING STRATEGY AND REALISTIC EXPECTATIONS

To guide our design decisions, we analyzed scoring opportunities and set realistic expectations for what our robot could achieve. Based on testing and practice simulations, we estimated achievable point ranges for autonomous, tele-operated play, and endgame tasks.

This analysis helped us prioritize shooter reliability, navigation, and consistency over more complex mechanisms with higher risk. We also tracked estimated practice scores over time to measure improvement and identify areas that needed more refinement.
By setting realistic goals and evaluating our performance honestly, we were able to make design and strategy decisions that matched our skill level and available practice time.

MATCH STRATEGY



AUTONOMOUS CAPABILITIES

At our first competition our autonomous mode consisted sheerly of a program to move the robot off of the line. Now, our robot can successfully shoot 3 balls and move off of the line setting up for the drive controlled portion. Moving our autonomous operation into an independent folder allowed for more efficient execution and maintainability. We scrapped our previous in progress webcam-based auto, which proved inconsistent during testing, with a reliable AprilTag webcam-free system.

Our new autonomous system features three distinct modes--select based on our alliance partner’s capabilities and preferences--changable via physical switch configurations corresponding to the robot's starting position on the field.

Key Improvements

- Modular Design: Autonomous routines are now isolated and easily configurable.
- Switch-Driven Selection: Enables quick pre-match mode changes without code re-deployment.
- Clean Transition: Autonomous cleanly hands off control to the driver without disruptive behavior.

```
id autons() {
    if (breakTime == -1) {
        breakTime = programTime.milliseconds() + 1250;
    }
    if (programTime.milliseconds() <= breakTime) {
        if (autoStep == 0) {
            arcadeDrive( forward: -1,  rotate: 0);
        } else if (autoStep == 1) {
            arcadeDrive( forward: 0,  rotate: 0);
            launch(!switch12.getState());
        } else if (autoStep == 2) {
            launch( shotRequested: false);
            launcher.setVelocity(STOP_SPEED);
            if (!switch12.getState()) {
                double turn = (switchLR.getState()) ? -0.5 : 0.5
                arcadeDrive( forward: 1, turn);
            }

        } else {
            arcadeDrive( forward: 0,  rotate: 0);
        }
    } else {
        autoStep++;
```

Autonomous mode is activated in the main loop by calling the `autons()` function. While active (`autons == true`), the robot:

1. Drives forward initially.
2. Reads the switch states to determine whether to shoot or reposition.
3. Uses `driveToTag()` and `faceTag()` functions to navigate to predetermined AprilTag locations based on the selected mode, ensuring optimal shooting distance and alignment.
4. Exits autonomous mode when both driver triggers are pressed, seamlessly transitioning to teleoperated `arcadeDrive()` control.

DRIVER CONTROLS

Our controller layout was designed so that each button has a clear and specific purpose.

Separating these actions helped make the robot easier to drive under pressure and reduced mistakes during competition.

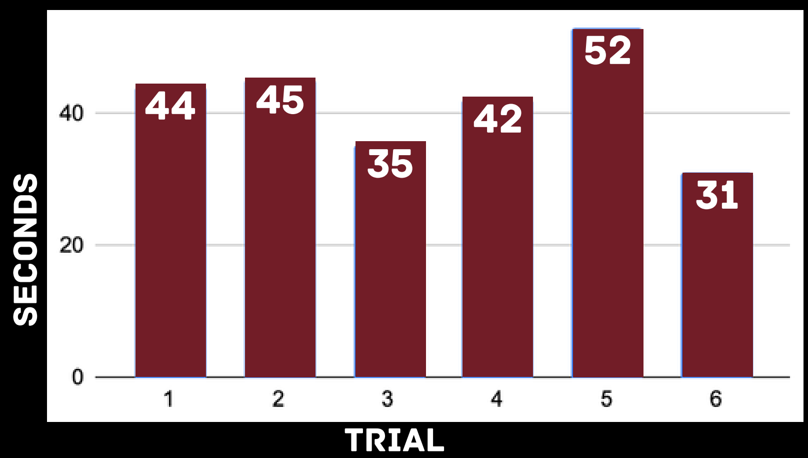
CONTROL PHILOSOPHY

When designing our control system, we focused on making the robot easy to drive accurately rather than as fast as possible. Early testing showed that running the robot at full speed made it harder to line up shots and increased the risk of collisions. Because of this, we prioritized precision, consistency, and reducing driver error during matches.

SPEED CONTROL AND PRECISION

We added multiple drive speed modes to improve control during matches. Testing showed that 100% speed was unnecessary for most situations and made precise movement harder, especially near scoring zones or field barriers. By allowing drivers to slow the robot down when needed, we were able to improve alignment and control without significantly reducing overall performance. Limiting the number of speed modes also kept the system simple and predictable for drivers.

TIME TO FILL THE CLASSIFIER



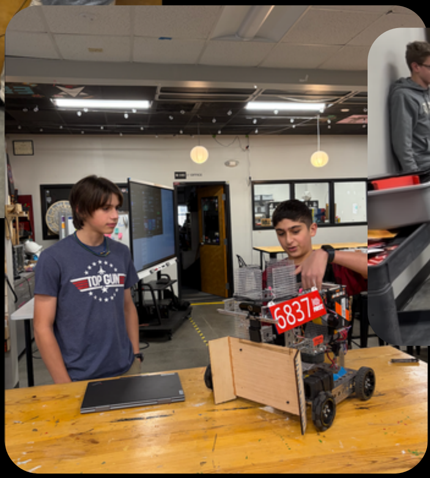
To determine how long it takes us to fill to classifier we ran the test represented by the chart on the left; the purpose of this data is to inform more data backed decisions during matches. We also ran trials to determine our cinsistancy and found it to be about 90% consistent.

OUTREACH & IMPACT

We recognize that our team benefits from strong mentorship and resources, and we actively look for ways to share that support with others. In December 2025, we presented our robot and explained FTC to over 400 students at our school's Community Meeting, which sparked interest and questions from the audience. We also assist our school's FLL teams by helping at their tournaments, offering design feedback, and inviting them to observe our FTC practices. Several of our members are part of FLL Team 4734 as members or mentors, creating a natural bridge between programs.

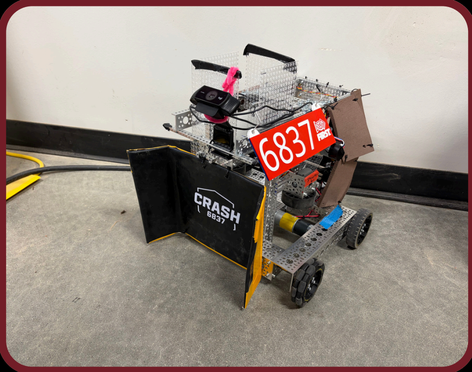
We've learned that explaining our work to others deepens our own understanding, and we carry that mindset into competition. At our first qualifier, we offered to cut and 3D print parts for other teams in our shop. Going forward, we aim to continue growing our outreach, especially by helping teams with fewer resources, because we believe collaboration and shared support strengthen the entire FIRST community.

OUTREACH



SOME OF MANY THINGS WE LEARNED

INTAKE SYSTEM



- We began intake system development too late in our season--adding an intake would have required massive redesigns, which was unrealistic with the time we had left and experience level.
- So we designed the “snowplow”.

WIRING STANDARDS

Unorganized wiring management caused issues during testing and repairs, slowing us down. Securing wires from the start would have saved time and frustration.

PROGRAMMING

During the programming phase of our robotics project, we encountered a variety of challenges ranging from minor coding errors to larger structural issues. Initially, our code was disorganized, prompting us to restructure it into a cleaner format before advancing to more complex features.
We utilized detailed flowcharts and planning sessions to deepen our understanding of the robot's integrated systems and to align our software with the hardware's capabilities. Following an iterative testing approach, we implemented changes incrementally and validated each on the physical robot to ensure integration in real time.

This process helped us identify an important lesson:
certain features we discussed during brainstorming sessions were impractical with the time limitations we were given, or unnecessary for the game.

LEADERSHIP ON OUR TEAM

Coding

Comp Vis
Jonas

Auto
Nina and Sadi

Controls
Jonas

Building

Competition Bot
All Builders!

H-Bot Design
Hannah, Sarthak, Emma

H-Bot Building
Emma

Snow Plow
Sarthak and Adam

Misc.

Outreach
Hannah and Sarthak

Portfolio
Emma and Hannah

Speech
Emma and Hannah

On our team we ensure that everyone takes ownership and is proud of their work. One way we do this is that we take responsibility for projects and act as leaders helping others participate meaningfully to the task at hand.

SUSTAINABILITY PLANS

One thing we have learned this year is that it is vital to have both those who are technically inclined and those interested in management/design. To add to the skill set of our team we have reached out to and even had people sit in on practice to learn and prepare for the next season!

We also decided to have two different levels--a robotics club where anyone is welcome to join and discuss robotics and an application based competitive Robotics Team, where members are required to be present at 75% of the monthly practices.

BUDJET

When our team first started, our technology director made sure we had what we needed to actually build and test a robot. That meant having access to a field kit, robot parts, and basic equipment so we weren't stuck waiting on supplies every time we wanted to try something new.
We know that this kind of support isn't something every team has. We don't see it as automatic or guaranteed. Having a stable budget mainly means we get more time to learn from mistakes, fix problems properly, and build things safely. Our goal is to build a program that sticks around and contributes back to FIRST, not just one that works for us this season.

OUR SEASON AT A GLANCE

- **9/11 – FTC Kickoff |** Team attended FTC Kickoff, gathered resources, clarified roles, set up logistics, and planned initial robot build, outreach, and communication systems.
- **9/15 – First Build Planning |** Established practice calendar, build groups, outreach goals, sponsorship considerations, and began field setup and space organization.
- **9/22 – Initial Build Progress |** Completed field setup, began chassis construction, reviewed budget trends, explored shirt designs, and planned software and vision setup.
- **9/29 – Early Robot Development |** Field build completed, robot build advanced toward wiring and wheels, coding environment set up, and strategy tools (FTC Sim, rules quizzes) introduced.
- **10/6 – First Motion! |** Robot successfully powered and moved for the first time, revealing build issues that informed better construction practices; Android Studio and wiring workflows established.
- **10/9 – Strategy & Iteration Planning |** Focused on improving shooting, wiring cleanliness, intake ideas, wheel configuration, and basic teleop control.
- **10/13 – Systems Integration |** Continued wiring and motor setup, began engineering notebook, explored computer vision options, and brainstormed robot redesigns.
- **10/20 – Software Foundations |** Control hub and GitHub workflows stabilized, servo alignment fixed, early cardboard mechanisms prototyped, and coding reliability improved.
- **10/27 – Intake & Launcher Prototyping |** Built and tested intake concepts, tuned servos and launcher mechanics, identified remaining practices, scheduled demos, and formalized portfolio structure.
- **11/3 – Infrastructure Milestones |** GitHub and coding environments finalized, controller layout designed, computer vision preliminarily functional, and outreach opportunities identified.
- **11/10 – Bot v2 & Vision Progress |** Advanced drive base and mecanum planning, improved launcher components, repaired drive chain, and achieved initial AprilTag recognition.
- **11/15 – Shooter & Control Refinement |** Improved weight distribution, upgraded motors, added traction materials, diagnosed encoder/PID issues, and planned additional practice sessions.
- **11/17 – Momentum Breakthrough |** Measured shooter speed with video tachometer, significantly improved shooting reliability, advanced HBOT construction, and strengthened team energy.
- **12/8 – Scoring Strategy & Reliability |** Achieved consistent shooting, refined snowplow prototype, formalized scoring targets, progressed AprilTag vision, and planned dual-robot practice.
- **12/11 – Competition Readiness |** Reviewed FTC rules, drive team requirements, safety protocols, and interview expectations to prepare for competition environment.
- **12/13 – Drive Team Formation |** Established drive teams and coaches, calibrated cameras, and continued preparing for match execution.
- **1/5 – Autonomous Advancement |** Made major portfolio progress, finalized chain installation, prototyped wooden snowplow, and achieved partial autonomous movement toward AprilTags.
- **1/7 – Small-Team Efficiency |** With limited attendance, improved wiring management, attached snowplow, practiced driving, and refined shooter angle decisions.
- **1/12/14/16 – Competition Push |** Converted brainstorms into polished portfolio content, dramatically improved shooter consistency, advanced autonomous logic, and began structured interview prep. Invited MS FLL team to experience FTC.