

# LIGERBOTS

A Guide to the LigerBots, 2023

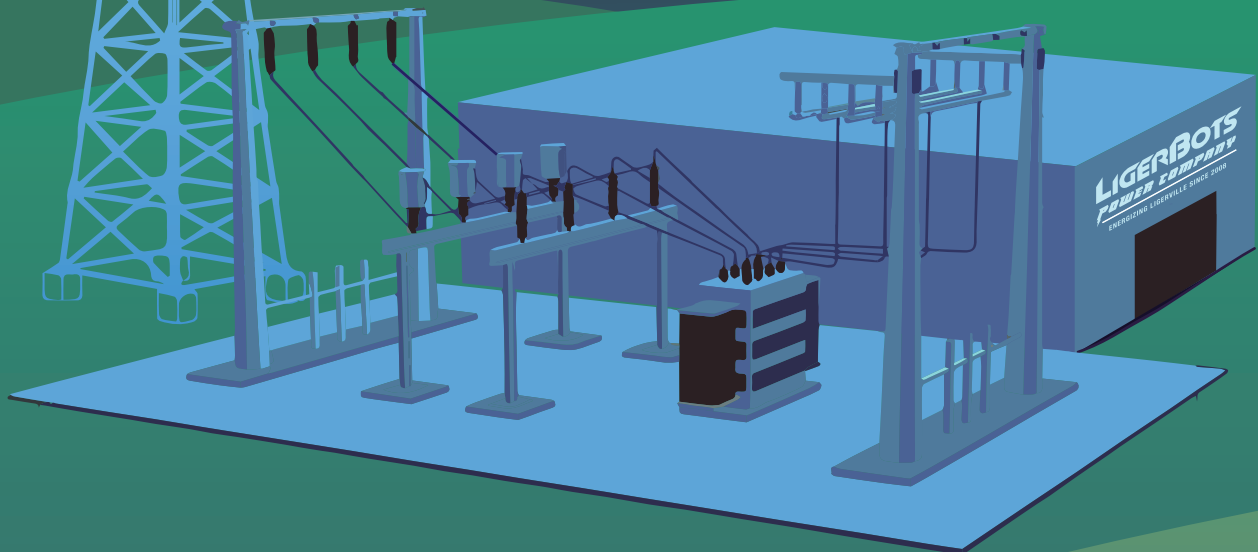
FIRST Robotics Team 2877

NEWTON NORTH AND SOUTH HIGH SCHOOLS

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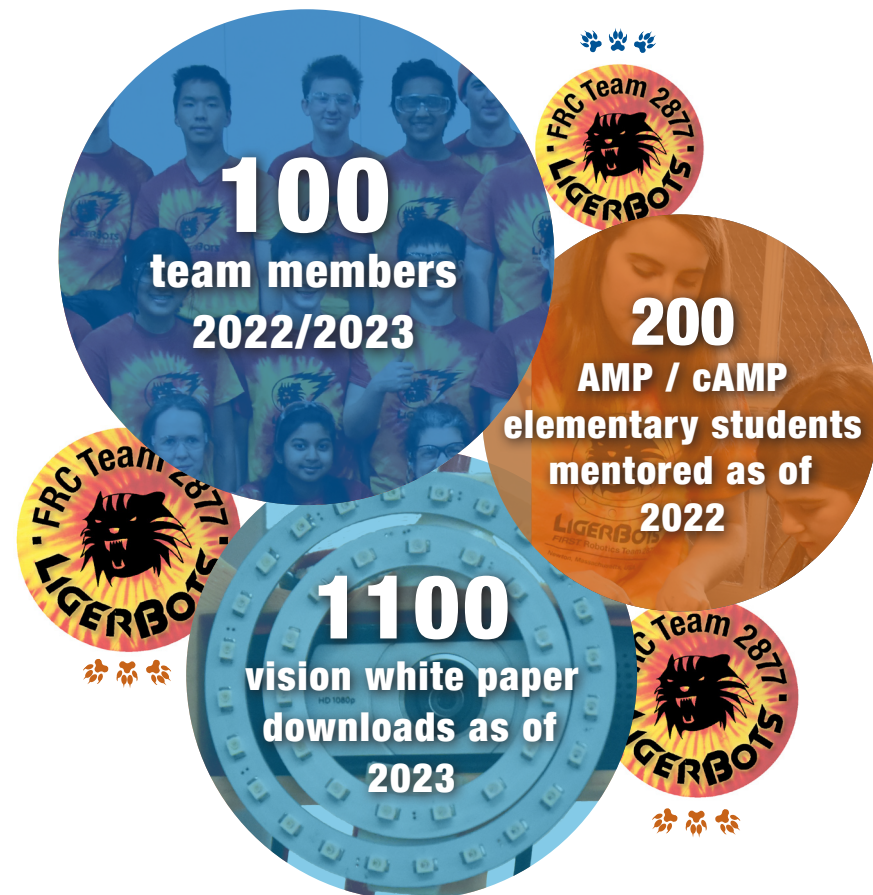
# LIGERBOTS



## A Guide to the LigerBots, 2023 FIRST Robotics Team 2877

NEWTON NORTH AND SOUTH HIGH SCHOOLS





*LigerBots at the New England FIRST District Championship, April 2022.*

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# LigerBots Lead in Project-Based Learning

*“Give the pupils something to do, not something to learn; and the doing is of such a nature as to demand thinking; learning naturally results.”*

— JOHN DEWEY, NINETEENTH-CENTURY EDUCATION REFORMER

 Little girls grab at pieces of colorful origami paper. They look up at the LigerBot instructor for help and quickly follow the first few instructions. But then things go awry. One little girl shoves her paper at the instructor, pleading for help. Others crease the papers in random places. Then one of the girls takes a new sheet to start over. She patiently goes step by step and finally completes the project. By the end of the session, all of the girls hold up their creations in triumph. From a single piece of paper, they have learned the engineering process.

As a team, we do more than build robots; we strive to encourage students to become the next generation of leaders and thinkers. We seek to change the way

students learn; our vision is to transform education through project-based learning.

Our goal is to become the recognized leader of project-based learning in Newton, Mass. To do that, we have created a system that uses hands-on projects to help team members build a strong and diverse set of skills. We then leverage those skills to advocate for project-based learning in the community by building a strong core of sponsors, educating the community, and establishing a sustainable FIRST LEGO League pipeline into our team. We share what we do in order to build and maintain the long-term strength of our team, foster a love for STEAM and encourage project-based learning at home.



Carolyn helps Girl Scouts do origami at the FLL Massachusetts East Championship expo.



Row 1: STEM advocacy—LigerBot delivers aTEDxBeaconStreet talk about FIRST as project based learning; STEM training—electrical mentor and CTO solder an electrical test bench. Row 2: sponsor relations—LigerBots outside Fowler High Precision after a successful sponsorship pitch; team outreach—LigerBots show kids how the robot works at Newton Highlands Village Day. Row 3: FIRST leadership—the participants at the FLL MA East Championship.



# LigerBots Do Hands-On Training



Our commitment to project-based learning starts as soon as students join the team. We spend our preseason teaching new LigerBots core skills through hands-on activities. As a first-year, one of our recent chief technical officers had trouble learning how to put together an FRC control system. To help, a mentor trained her with a virtual, magnetic electrical system. After her training, the CTO was able to use the same techniques to teach other students and could help her parents with small electrical projects. Our current graphics director joined the team with a background in digital art but no graphic design experience. With help from the graphics mentor, she learned how to use professional graphic design software and began leading the redesign of the team website.

We start training each year by breaking first-years into groups; then, using previous FIRST games as a guide, we have students create game strategies and designs to teach them the engineering process. Each

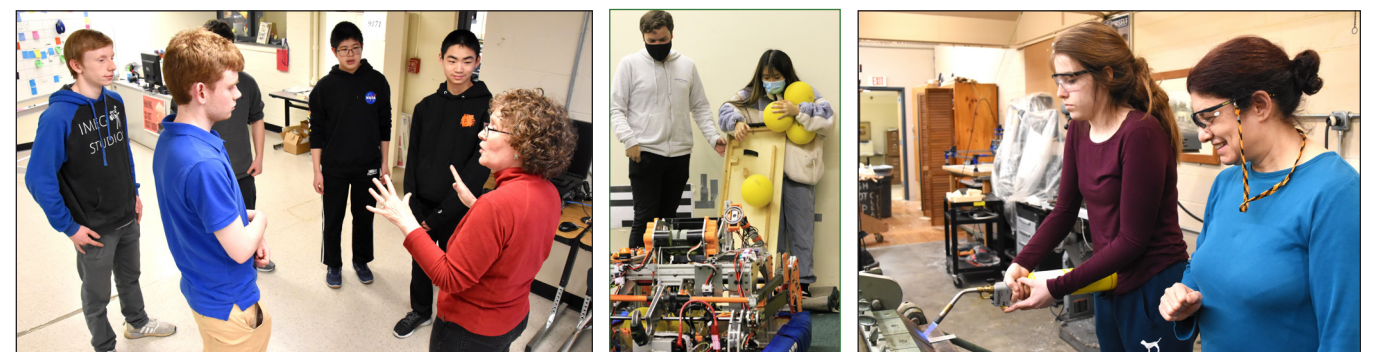
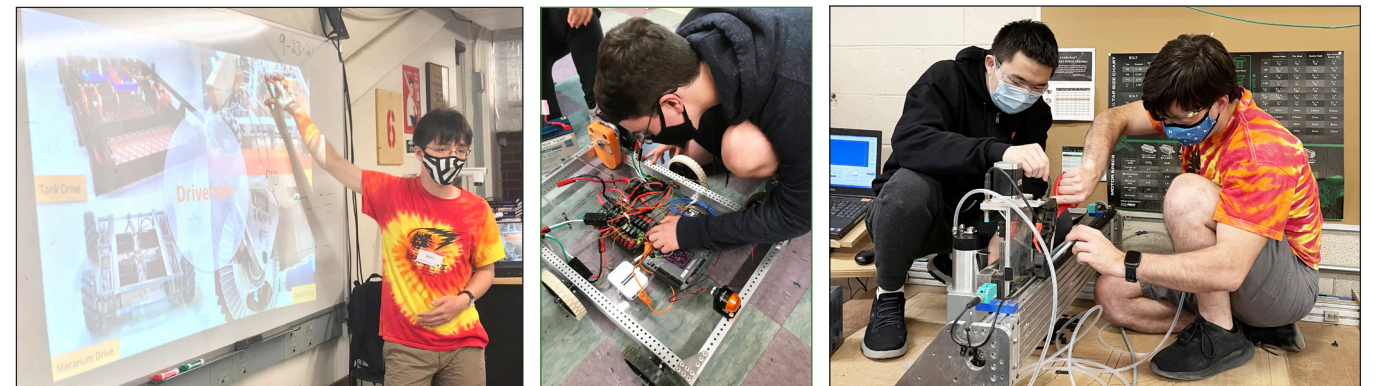
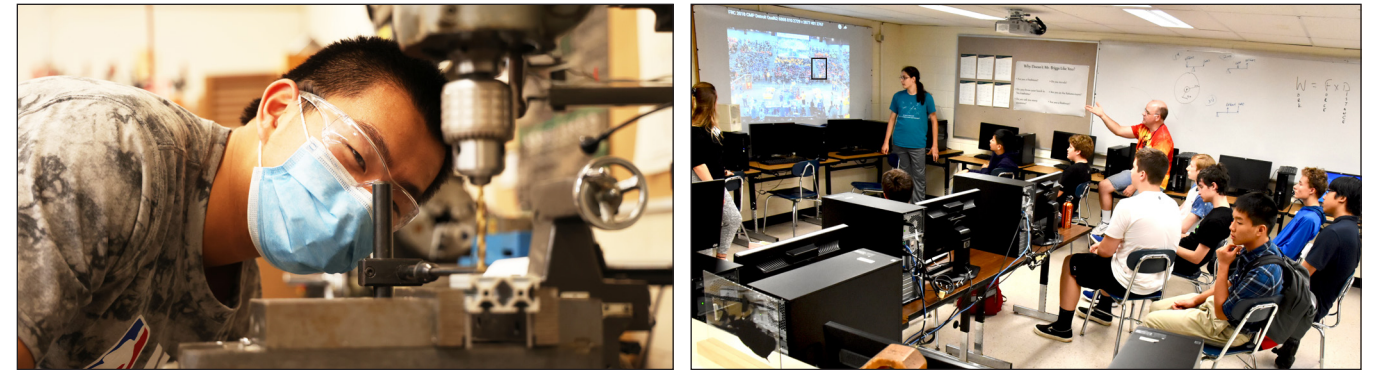
group then presents its designs to the rest of the team, which helps build presentation skills, as well as exposing the team to diverse engineering approaches.

Our broad preseason training has also resulted in team members understanding the wide variety of ways they can contribute to the team. For instance, a recent CMO learned to bend and mold polycarbonate to make a hinge, and our students who usually concentrate on technical projects regularly help with team fundraising and blog posts.

As a result of our training projects we have published four white papers on Chief Delphi that have received thousands of views and downloads: on robot vision, on the measurement of display latency, on making an electrical test bench, and on distance learning and teaching. We share our robot code on GitHub, maintain a robot build blog as part of the Open Alliance on Chief Delphi, and publish our CAD on Onshape.



*A new LigerBot learns to disassemble a motor.*



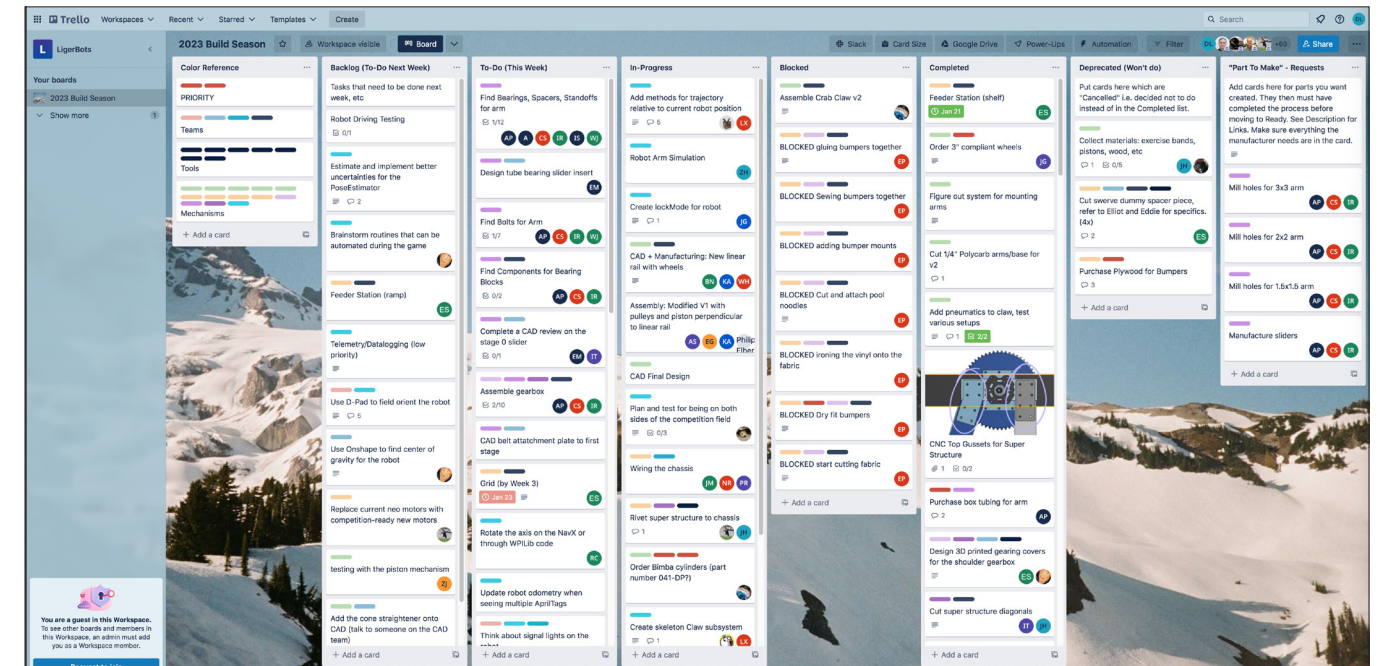
*Row 1: LigerBot jewelery a piece of metal; watching previous years' games to learn strategy. Row 2: explaining types of drive trains; wiring up the control system for a demo robot; setting up the computer numerically controlled (CNC) router. Row 3: assembling an intake arm prototype; showing first-years how to wire the brushless motor test bench. Row 4: improving public speaking; learning how intakes work; practicing the bending of metal sheets using heat.*



# LigerBots Acquire Many Skill Sets

- **Shop safety.** Keeping our fingers and eyes intact as we work on the robot
- **Basic training.** Learning the functioning of basic mechanisms, motors, sensors, electrical and pneumatic components, and use of CAD software
- **Use of machines.** Using the band saw, hand drill, mill, drill press, and lathe
- **Precision manufacturing.** Improving our ability to cut and mill pieces of metal precisely into specific parts using a CNC router
- **Programming.** Building a robot operating system out of Java and detecting field objects using machine vision
- **Electrical.** Soldering, crimping, building prototype boards, CADing electrical layouts, and learning electrical physics principles
- **Swerve Drive Train:** Building and experimenting with a new differential swerve gearbox and drivetrain
- **Computer-aided design.** Designing a robot using PTC's Onshape and following a workflow that allows for multiple collaborators, redesigns, and mechanism additions
- **Custom gearboxes.** Creating custom gearboxes in order to practice use of the band saw, machining on the CNC, and assembling parts.
- **Game Strategy.** Watching robot games online and at live events prior to our own competitions to learn how to evaluate robots for their potential as alliance partners when we compete
- **Public speaking.** Creating a narrative and visuals and presenting them effectively to FIRST Robotics judges, sponsors, and the public
- **Elevator pitches.** Constructing spontaneous, 60-second speeches about the LigerBots and FIRST, to use whenever someone asks us about the team. Practicing it in pairs and presenting to the team
- **Technical writing.** Writing white papers, using LaTeX, that convey technical information about LigerBots projects in a concise, informative, and persuasive manner
- **Grant writing and sponsorship.** Writing formal grant proposals to potential sponsors and approaching sponsors that don't have a formal grant process
- **Writing for publicity.** Writing for different formats: blog posts, sponsor relations, media relations, social media, government relations, and FIRST awards applications. Using tools such as MailChimp
- **Leading an outreach event.** Organizing the logistics for a LigerBots robot demonstration and outreach table
- **Photography.** Composing photographs and using the "exposure triangle," as an aid to documenting team projects. Using Flickr to keep all of our photos organized
- **Video editing:** Shooting and editing video for FIRST award submissions, robot videos and other special projects
- **Graphic design.** Creating graphical documents for team marketing and publicity, using Adobe Creative Suite and Creative Cloud.
- **Sewing.** Cutting and sewing soft materials to prepare for making bags and robot bumpers in build season

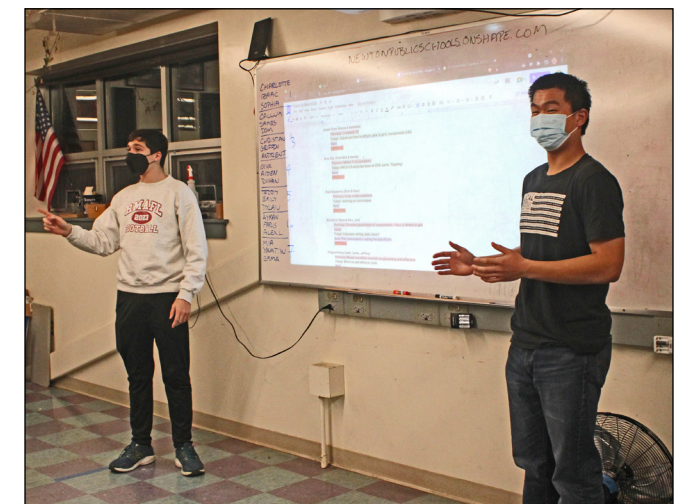
# LigerBots Manage Our Projects



A Trello board showing the state of various robot build tasks in early February 2023.




The LigerBots use detailed project management for all of our tasks. We use the KanBan process to track and control our business projects and robot manufacturing progress during the robot build season. We create Trello boards for our non-technical and technical projects. Students sign up for individual tasks on the Trello board and follow them through from "not started," to "in progress" to "done," moving the Trello cards for their tasks to different columns on the board as they progress. A column for "blocked" projects helps us clear our bottlenecks. We also run stand-up meetings at the beginning of each meeting during the robot build season so that groups can update each other on their projects in person. This system helps us finish our robot earlier than in previous seasons so that we can go on to testing it before competition. LigerBots transfer their new sophistication in planning projects to their academic work and other extracurricular activities, and teach these skills to other students.



Co-CTOs Nate and Kevin present at a stand-up meeting.



# We Build a New 120-Pound Robot Every Year

 All of the LigerBots fall training in engineering and marketing skills pays off during the most exciting and demanding part of our year, the winter robot build season.

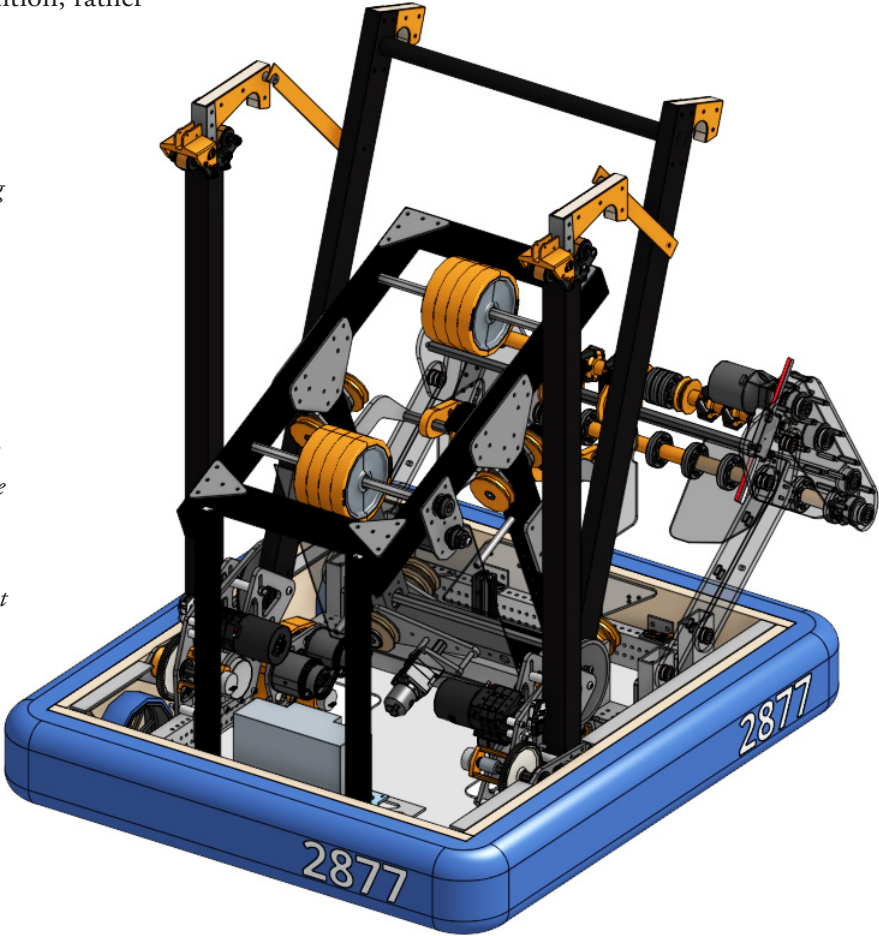
Immediately after the new FIRST Robotics game is released in early January, the entire team splits into groups for our “three-day design” process. Engineering concepts and game strategy that emerge from our three-day design groups are reconciled by leaders of our mechanical, electrical, and software build groups and a final product is designed using CAD. After the design phase, we begin prototyping robot mechanisms and constructing mockups of the game field elements. We order our wood, metal, plastic, and cloth materials and set to work building in the shop at Newton South High School.

Current rules from FIRST allow us to work on our robot right up until the day of competition, rather

than having to stop after six weeks and put the robot into a giant plastic bag, as before. This new rule has allowed us to save the money and time necessary to build a second robot for continued testing after the first robot was “in the bag.” This gives us more time and money to spend on improving our competition robot.

During build season our marketing and awards groups are just as busy as the engineers. We finalize sponsor acquisition for the competition season and write and design website pages and printed materials, including this booklet, that recognize our sponsors. Outreach also continues. Our awards group prepares a written submission and an oral presentation to compete for the FIRST Impact Award, which goes to the team at each competition that best exemplifies the principles of FIRST Robotics.

*This page: the LigerBots 2022 robot, “Prometheus.” Opposite page, row 1: attaching the first intake prototype to a mock bumper to test the geometry; testing a catapult on the 2016 robot; cutting aluminum plates on the CNC. Row 2: testing a rudimentary version of the shooter; checking the dimensions of the chassis; assembling the climber gearboxes. Row 3: drilling mounting holes into a climber arm; troubleshooting the linkage arms; attaching the first version of the intake to the chassis. Row 4: wiring the chassis; testing a prototype of the climber on an old robot; testing the 2022 robot with a mockup “Hub” field element goal.*



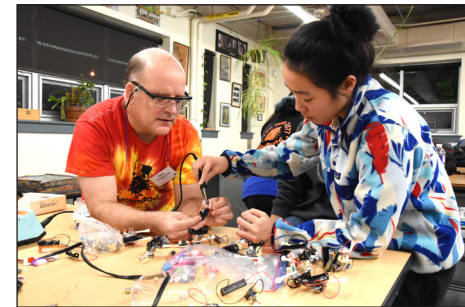


# LigerBots Robot Design Process

## PRESEASON TRAINING AND IMPROVEMENTS

### Hands-on Projects

- LigerBots preseason training starts with projects that get new members working hands-on in the shop, with robot components, as fast as possible. In the fall, LigerBots run training sessions in many of our 20 team skill areas, including ten in technical areas. Examples from 2022 include:
  - Strategizing, brainstorming mechanisms, and prototyping the mechanisms for a previous FRC game.
  - Building and testing our first competition-ready swerve drive.
  - Prototyping new mechanisms to handle an array of game pieces.
  - Using simulations of mechanisms to write training software for Arduinos, and then test it on the previous year's robot.



LigerBots coach teaches a first-year to solder.



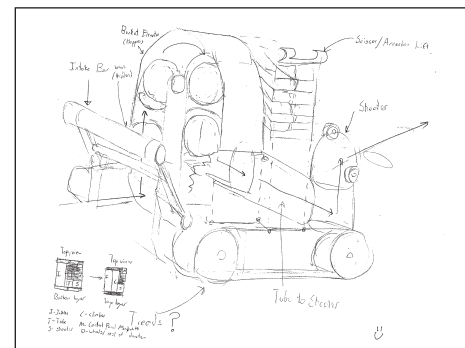
LigerBots veteran teaches a first-year to use the CNC mill to precisely drill a hole.

### Game Analysis

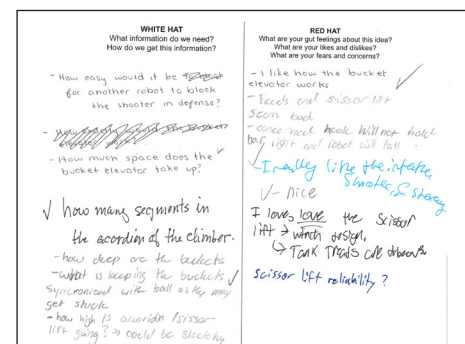
- Veteran LigerBots choose videos of matches from the previous several seasons of robot games. Team members, especially first-years, are invited to watch these videos in a group and think about robot design and game strategy before the new build season.

### Improvements to Manufacturing Processes

- Creating an internal bill of materials (BOM) for sub-projects, to improve project management.
- Training students on the lathe to expand manufacturing capabilities.
- Rebuilding one of our lathes to restore it to a usable condition.
- Preparing students to mill metal during build season with projects using metal tubing.
- Using 3D printing to manufacture complex parts suitable for solving many robot design problems.
- Teaching students how to do computer assisted manufacturing (CAM) in Fusion 360.
- Using team-built electrical and pneumatic test benches to help us prototype electrical wiring and pneumatic mechanisms.



Sketch of a potential robot design.



Critiques of above sketch.

## ITERATIVE ROBOT DESIGN

### Design Week

- **Day 1:** Right after the game kickoff, the team meets in small groups to analyze the game and discuss potential robot capabilities and advantages.
- **Days 2 and 3:** We continue in our small groups to brainstorm mechanisms that best implement our strategy.
- **Day 4:** Our build leaders meet to review team comments about mechanism designs and decide which mechanisms to prototype. Other team members are encouraged to listen to the discussion so that they learn how to lead the process in the future.
- **Days 5–7:** We split into build groups to start prototyping.

### Robot Design and CAD

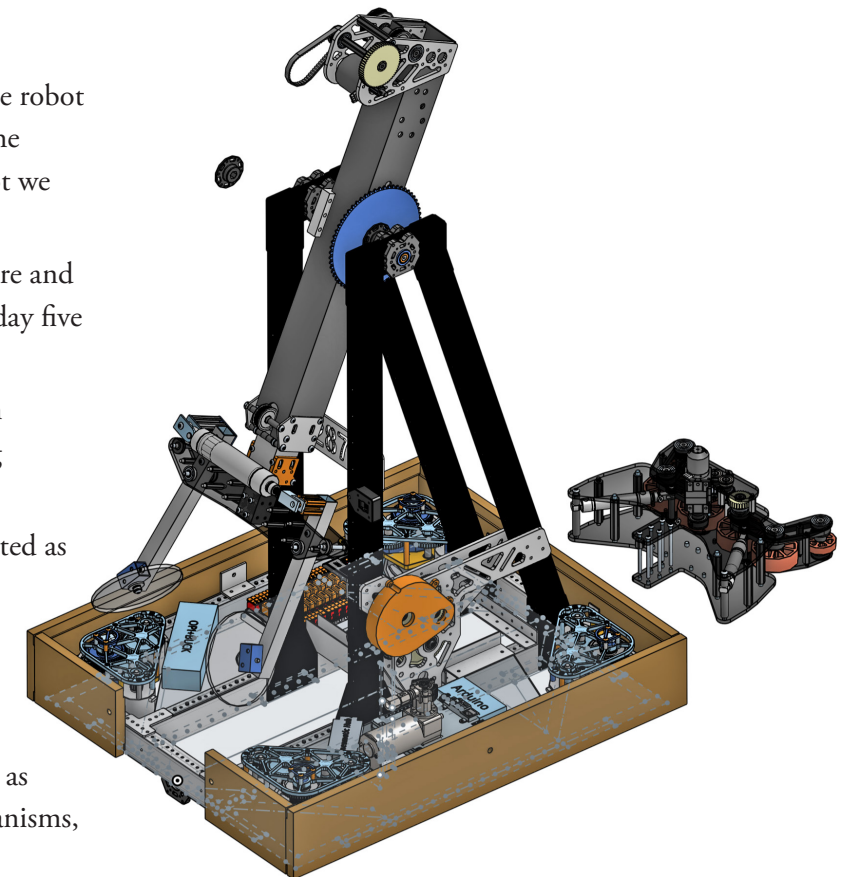
- Game strategy determines our priorities. The robot is built to best fit our strategy, rather than the strategy changing to accommodate the robot we build.
- Students design and CAD the robot structure and begin prototyping mechanisms starting on day five of design week.
- After design week, mechanism groups begin detailed design and CAD of each promising mechanism.
- A CAD model of the entire robot is completed as quickly and thoroughly as possible.

### Prototyping and Continuous Improvement

- Prototypes are built of materials as identical as possible to materials used in the final mechanisms, allowing more realistic test results.
- LigerBots continue to test, redesign, and prototype mechanisms.

### Project Management

- Mechanism groups with student leaders are formed during build season, allowing every LigerBot to concentrate on and feel ownership for one part of the robot. Fluidity of groups ensures the team's needs are always filled.
- A project management system, centered around an online Trello board for project planning and staffing, allows students to find tasks that need completing and track progress.
- The Trello board is supplemented by daily stand-up meetings and weekly group integration meetings, ensuring that the team is working toward its goals.



LigerBots 2023 robot CAD, in progress.



# LigerBots Compete



FIRST Robotics competitions are the big payoff for all of the LigerBots training and build season work. At these competitions our robot performance, our driving skill and strategy, our awards preparation, and our marketing efforts are all put to the test. We enter two district (first tier) events every year. When we do well at these events we go on to compete at the New England District Championship, and, if we do well there, we go to the FIRST World Championship in Detroit. The LigerBots have made it to the World Championship four times in our first ten years. In 2018 we finished sixth out of 68 teams in our division and advanced to the division semifinals before falling to the eventual world champion alliance.

FIRST Robotics qualifying matches are played by two randomly selected alliances of three teams each, on a playing field about the size of a basketball court. We have a different alliance for each qualifying match. Our alliance drive teams guide our robots around the field to earn points cooperatively and to keep the other

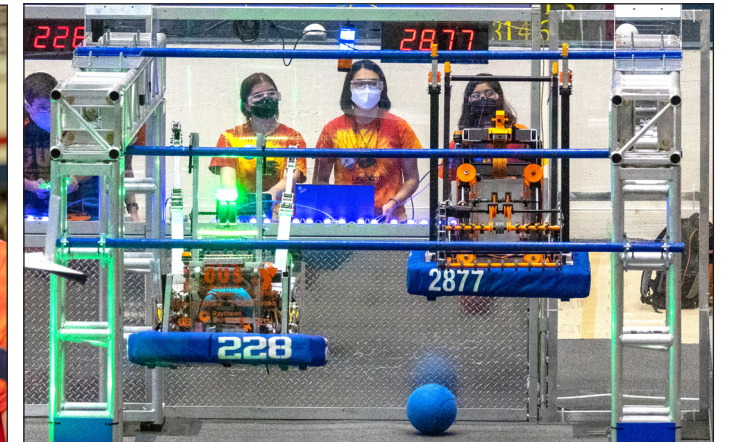
alliance from scoring. Everyone on our team sits in the stands to cheer on our robot. Our scouts take notes on every team's robot performance so that we can choose partner teams wisely if we become an alliance captain during the playoffs.

Our pit technicians repair our robot between matches when something breaks. We also lend tools and materials and repair the robots of other teams in the FIRST spirit of "coopertition."

During competitions team members stand in our repair pit and talk to FIRST judges about the robot and about our team's organization and activities. LigerBots also give a formal presentation to compete for the prestigious FIRST Impact Award, which sends the winning team automatically to the next level of competition no matter how its robot performs. Every year our efforts have resulted in at least one award for our team, for a total of 31 awards during our first 13 years.



*This page: the arena at the 2022 New England District Championship, in West Springfield, MA. Opposite page clockwise from upper left: LigerBots repair the robot in the pit; LigerBots drive team hangs the 2022 robot on a bar during the endgame; LigerBots talk to awards judges; 2022 robot on the playing field; LigerBots cheer in the stands; LigerBots receive an award; drive team and pit crew in the pit.*





# LigerBots Design an Award-Winning Game

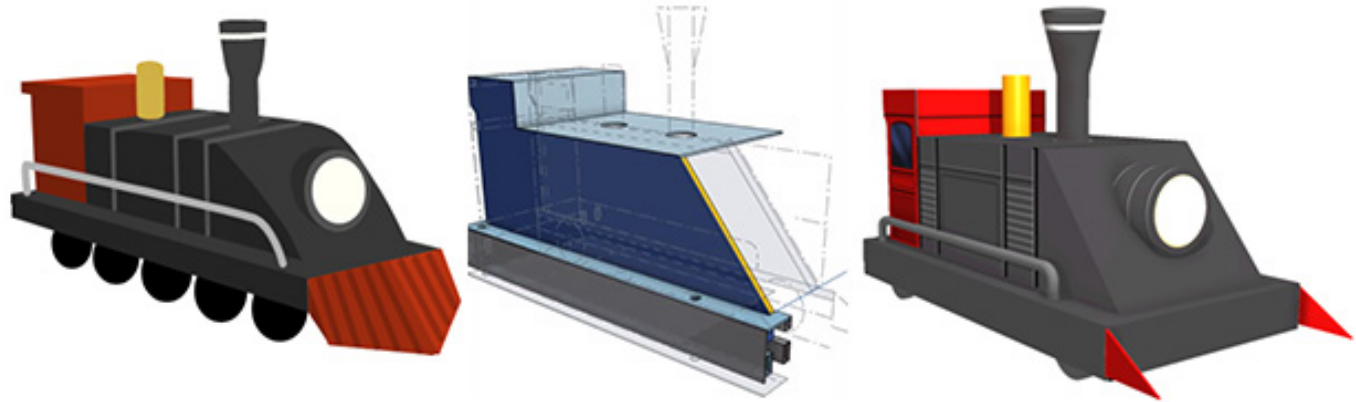
The LigerBots are an award-winning team even when we have to go virtual! Since Covid-19 canceled the 2021 in-person competition season, FIRST released three challenges that teams could complete online and then submit for awards. One was a series of robot skill challenges that could be executed with the previous year's robot and videotaped for award submission. The other two challenges were meant to be done completely online. One of them, the Game Design Challenge, invited teams to design their very own FIRST Robotics game and pitch it to the corporate FIRST Robotics Competition game design team, to inspire a future FRC game.

The Game Design Challenge presented a unique opportunity for various LigerBots skill groups to collaborate closely in order to execute a shared vision. Each group offered valuable knowledge and diverse perspectives to the development of the game. Our strategy group worked with our engineers to detail the game logic and rules. The graphics group worked extensively with the engineers to create visuals for the game. Our marketing students brought essential project manage-

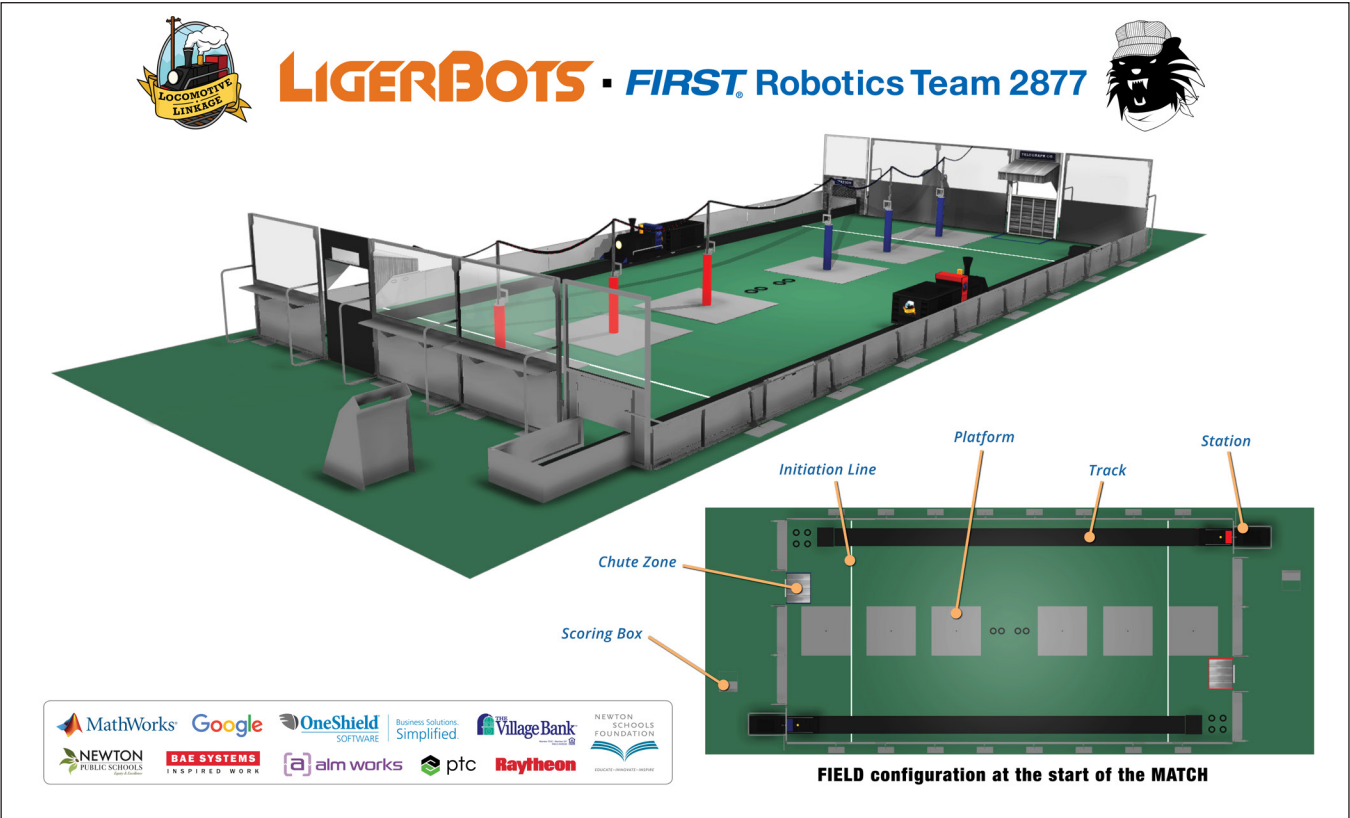
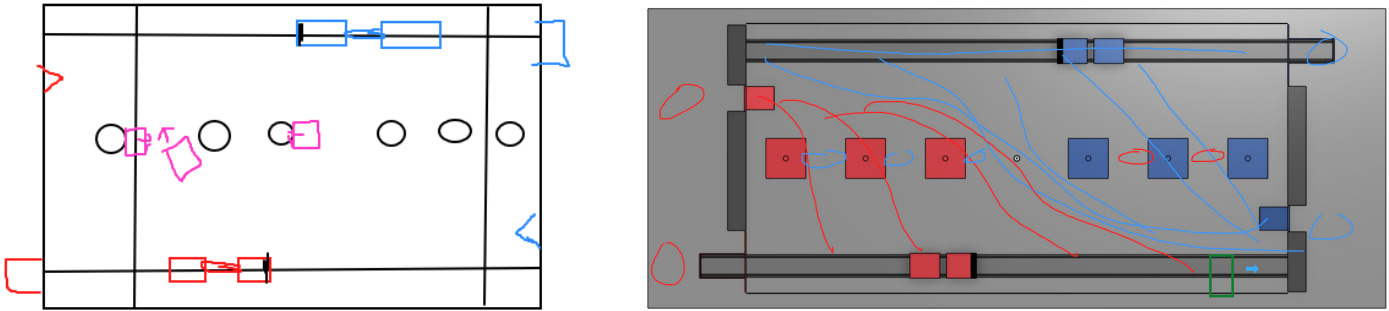
ment to streamline the partnership between the groups.

The LigerBots developed a concept involving trains owned by two rival construction companies that were competing to complete new telegraph systems for two nineteenth-century towns. We called the game "Locomotive Linkage." Each robot alliance (of three teams) represented one of the construction companies. Robots earned points by pulling on their locomotive to move their train back and forth on its track, and by collecting "lumber" (foam cylinder game pieces) to put in the train's gondola car. Robots also earned points by climbing a "telegraph pole" in the center of the field, or by toggling an elevated switch attached to the pole.

We were thrilled to learn a few weeks after we completed the challenge that we had won the Engineering Design award from FIRST at the district level! The hours spent together on Zoom strengthening our final game design also strengthened our team spirit. Since the 2021 season we have remembered our pride in our award and the lessons we learned about cross-team collaboration. We think the LigerBots will always be stronger for our 2021 experience.



Left image: train design drawn by a LigerBots graphics artist. Center image: in-progress CAD of train design. Right image: finished CAD render of train done by a LigerBots engineer, with textures by LigerBots graphics artists.



**Game Overview:**

In LOCOMOTIVE LINKAGE, rival telegraph companies join forces to link the people of Redton and Blueburg by transporting TELEGRAPH POLES to the building sites of each town's telegraph network. ROBOTS from each ALLIANCE town collect LUMBER from a telegraph pole factory via a CHUTE, move their TRAIN along the TRACKS, and put LUMBER into their GONDOLA CAR. They send the TRAIN back to its STATION to be unloaded, then race off to collect more LUMBER. ROBOTS PRIME TELEGRAPH POLES by toggling the POLES' SWITCHES to accept a message. As the deadline for the telegram between the cities approaches, ROBOTS CLIMB up the POLES or PARK on the PLATFORM to perform final wire maintenance that will ease the transmission. The winning ALLIANCE is the one that has made the biggest contribution to the new telegraph system.

**AUTONOMOUS PERIOD:** During the 15-second AUTONOMOUS PERIOD, ROBOTS follow pre-programmed instructions. ALLIANCES score points by:

1. Moving from the STARTING ZONE.
2. PRIMING SWITCHES.


**TELEOP PERIOD:** In the final 2 minutes and 15 seconds of the MATCH, DRIVERS take control of their ROBOTS. ALLIANCES score points by:



Row 1: initial field design sketch; CAD of field. Row 2: final CAD render of field done by LigerBots engineers, with textures by LigerBots graphics artists. Row 3: partial game rules; Locomotive Linkage game logo; Locomotive Linkage-themed team logo.



# LigerBots Innovate to Help the Deaf Community

 With Covid-19 reshaping the 2021 competition season, the LigerBots were excited to take on an online challenge created by FIRST: the Innovation Challenge. This challenge required engineering, programming, and marketing skills to design a solution that helped people achieve “optimum physical and/or mental health and fitness through active play or movement.” In other words, teams were asked to devise and pitch a solution to encourage physical activity.

One of the LigerBots noticed that none of the young athletes for whom he refereed soccer were from the Deaf or Hard-of-Hearing community. So, he had the idea to make a non-auditory whistle that would encourage participation by hearing-impaired athletes in team sports. After receiving feedback and concept validation from members of the Deaf and Hard-of-Hearing community, the team committed to pursuing the idea. We spoke with industry experts from iRobot, Excella, and Neosensory about the process of product design and continued to interact with the Deaf and Hard-of-Hearing community along the way, for feedback. We got to know Rory, a six-year-old who felt discouraged from team sports because of overstimulation from his hearing aids. Rory’s story and the overwhelmingly positive responses from surveys and interviews inspired our work. Katie McCarthy, a coordinator of outreach and support services at Boston Children’s Hospital, described our project as a “won-

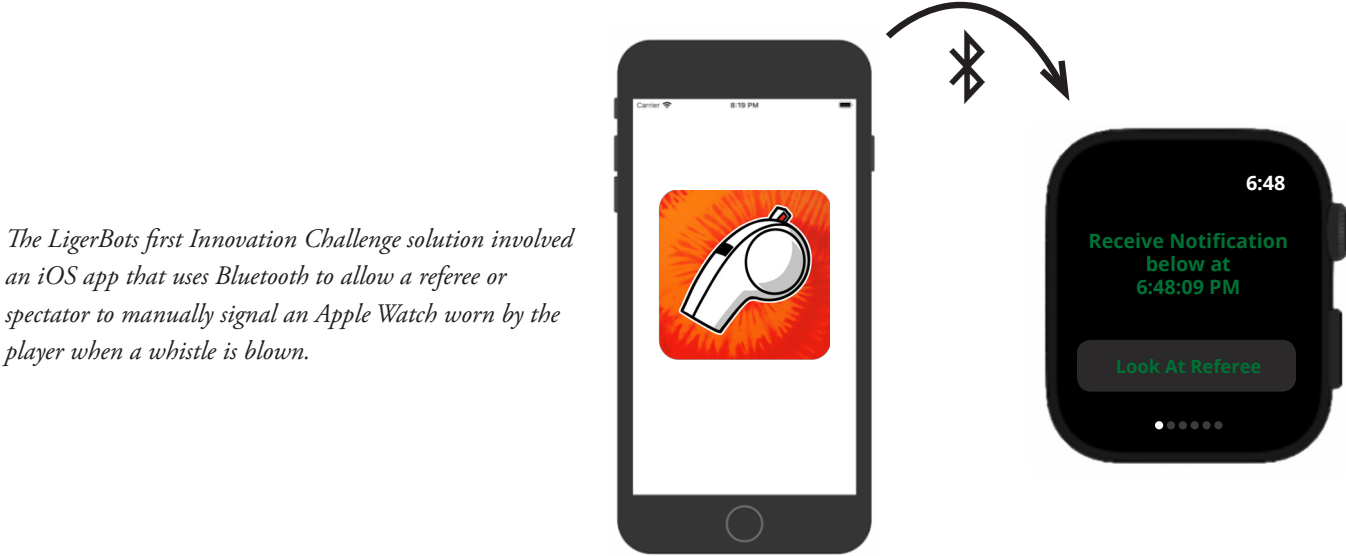
derful opportunity and a great chance to help Deaf and Hard of Hearing athletes in team sports.”

The LigerBots developed two different solutions: an iOS app and a custom hardware design. For the first, more accessible solution, LigerBots designed the LigerWhistle, an app a coach or spectator can use to manually signal a player’s Apple Watch (worn on a chest strap) when the referee whistles. The second custom solution involved a device worn by the referee that automatically recognizes when they blow the whistle and sends a radio signal to a vibrating motor the player wears on a chest strap.

The Innovation Challenge offered a unique opportunity at all of its stages for the LigerBots to solve a real-world problem with a real-world impact. Students completed the challenge with priceless, firsthand knowledge of the steps in launching a business, from research to realization. In addition, LigerBots team members learned how to file a provisional patent, for the LigerWhistle and the iOS app. The process of outlining, drafting, and submitting was intense, compounded by the difficulties of working over Zoom. Fortunately, we succeeded in filing the application, and even received praise for our work from a local patent lawyer. Throughout the process we learned valuable skills such as project management and translation of technical ideas into “legalese.” Submitting the patent application was a huge accomplishment, and a new and valuable experience for the LigerBots.

Description:		<p>methods, for example, including but not limited to Bluetooth®, Bluetooth Low Energy (BLE)® and Lo-Ra, to communicate over a distance that covers the entirety of the playing surface. We provide methods for all devices worn by officials and players to be worn in such a manner that maximizes safety and conformity with league and team requirements, for example, including but not limited to with a chest strap, armband, or waist clip. The invention may be implemented as two agent (two people involved in the communication process) (as seen in figure three) or three agent (three people involved in the communication process) (as seen in figure four) approaches. Figure one provides a general example of the interactions between the agents and devices involved in both the two and three agent systems.</p> <p>Figures three and four show an example of a field of play. These images highlight the maximum dimensions of one of the fields of play in which our device could be used. The dimensions of this field are the maximum regulation sizes used for an IFAB soccer game.</p>
Section 1: General		
Section 2: Automatic Sound Detection Device		
Section 3: Human to Device Detection		
Section 4: Casing and securing		
Section 5: Use cases (sports and non-sports)		
Section 6: Summary of advantages		
Section 7: Acknowledgement of possibilities		
Section 1:		
Our invention enables non-auditory communication between one or more officials, such as referees, coaches, or other people of authority recognized in a sport, and one or more deaf or hearing impaired players in a team sport or individual sport environment, utilizing a set of one or more transmitting devices and one or more haptic devices. Our invention allows for a referee or other official to use their standard method of signaling, for example an unmodified whistle, minimizing impact on the game. Our solution utilizes intermediate-range communication		Section 2:
One embodiment of the invention, implemented as a two-agent system, comprises a first device or group of devices (henceforth listening device) each worn or carried by a person in		

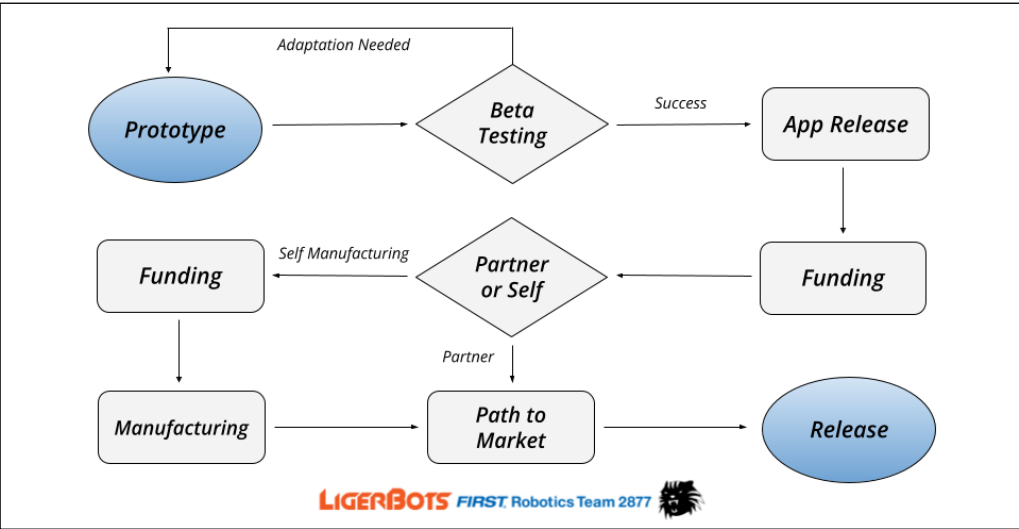
Provisional patent application (partial).



The LigerBots first Innovation Challenge solution involved an iOS app that uses Bluetooth to allow a referee or spectator to manually signal an Apple Watch worn by the player when a whistle is blown.

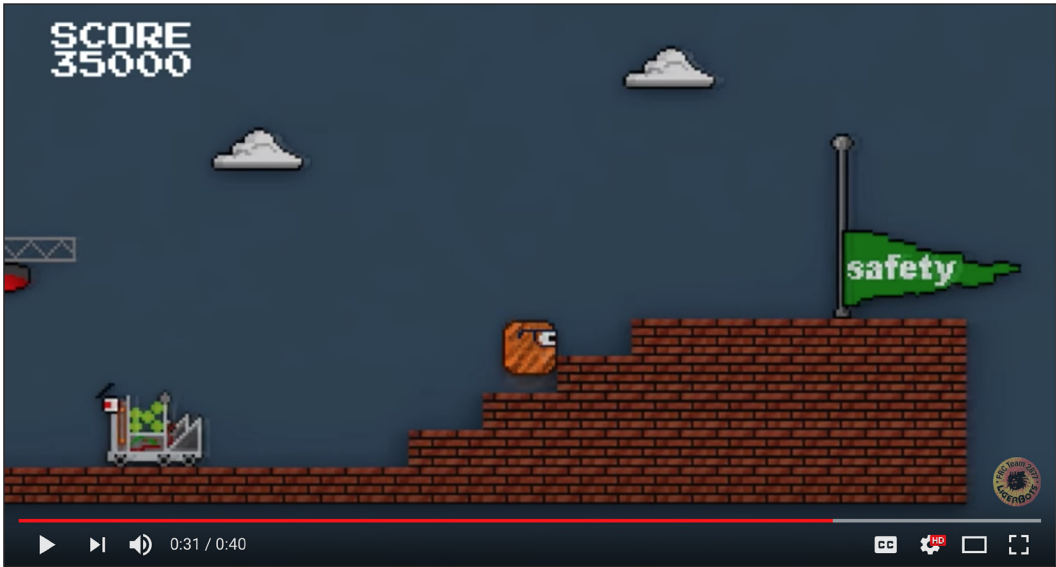



The second Innovation Challenge solution used two custom pieces: a device worn by the referee that emits a radio signal when it perceives a whistle being blown, and a vibrating motor worn on a chest strap by the player.



Workflow chart that shows steps from prototype to release for inventing a new product. For the Innovation Challenge, the LigerBots completed beta testing.

# LigerBots Win the Safety Animation Contest



 In 2018 the LigerBots won our first international award—first place in the world-wide FIRST Robotics Safety Animation competition. Our winning video was shown at many FIRST Robotics competitions to about half a million spectators over the 2018 season. These animated videos combine an educational message about safety with creative art and imagery.

### How We Made the Video

In order to follow the retro-1980s arcade theme of the 2018 FRC challenge, we developed a story that combined safety principles with elements of our very own video game. We designed characters and scenery and brought them to life with 3D animation. Finally, we added arcade-style music and sound effects along with a voice-over narration by a LigerBots team member to accompany the visuals.

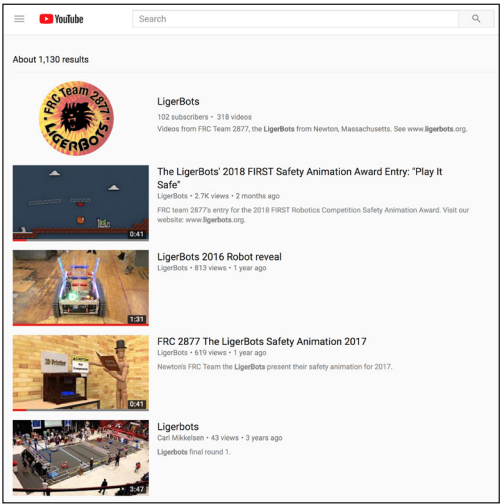
### Rising to the Animation Challenge

According to LigerBots’ animator Vivek, the biggest challenge was fitting the story into only 40 seconds—the maximum time allowed by rule. The deadline also provided an obstacle, forcing us to make fast decisions and to start the animation process early.

“It took considerable work,” said Vivek, “but I’m excited about what it means for our team. It got me thinking about STEM vs STEAM and how the ‘A’ Art factor ties into the work we do.”

We are proud of the work the team did to win this prestigious award and hope that our video will have a lasting impact on the community by encouraging safe practices.

The public can subscribe to our YouTube channel to see this video and all the rest of our team videos.



LigerBots YouTube channel.

# LigerBots FIRST Awards

Year	Event	Award
2022	New England Championship North Shore District	Engineering Inspiration Gracious Professionalism
2021	FRC Game Design Challenge Scandium Group	Engineering Design
2020	Greater Boston District N. Connecticut District	Chairman's Imagery
2019	New England Championship Central Mass District	FIRST Dean's List Finalist Entrepreneurship
2018	Worldwide competition Greater Boston District North Shore District	Safety Animation Engineering Inspiration Imagery
2017	Rhode Island District WPI District	Entrepreneurship Gracious Professionalism
2016	New England Championship WPI District Boston District	Innovation in Control Entrepreneurship Innovation in Control
2015	New England Championship Northeastern District UMass Dartmouth District	Chairman's Competition Finalist Chairman's
2014	Northeastern District  WPI District	Competition Finalist Spirit Competition Winner Creativity
2013	Boston Regional	Creativity
2012	Boston Regional WPI Regional	Gracious Professionalism Gracious Professionalism
2011	WPI Regional	Website Dean's List Finalist
2010	Boston Regional WPI Regional	Team Spirit Imagery
2009	Hartford Regional  Boston Regional	Rookie Inspiration Highest Rookie Seed Rookie All-Star Highest Rookie Seed

**The FIRST Impact Award**, previously known as the Chairman’s Award, is the most prestigious award that FIRST offers, honoring the team that best displays the values and goals of FIRST, while also being a role model for other teams. In 2020 the LigerBots won at the district level. In 2015 the LigerBots won at both the district and NE Championship levels, which qualified the team to compete at the FRC World Championship in St. Louis. Judges chose the LigerBots for the work the team did to spread the message of STEM around Newton and beyond, through education and outreach.

**The FIRST Dean’s List Award** semi-finalists, finalists, and winners are students who have led their teams and communities to increased awareness of FIRST and its mission. These students have also achieved personal technical expertise and accomplishment.

**The Engineering Design Award** celebrates a team that demonstrates sound engineering in the design process.

**The Imagery Award** celebrates attractiveness in engineering and outstanding visual aesthetic integration of machine and team appearance.

**The Safety Animation Award** is the result of a world-wide competition, and is given to the team that produces the best 40-second animated video that combines an educational message about shop safety with creative art and imagery. The LigerBots’ winning 2018 video was shown internationally at many FRC competitions.

**The Entrepreneurship Award** recognizes a team that has developed a comprehensive business plan to scope, manage, and achieve team objectives. Judges chose the LigerBots in 2016 for the team’s work in expanding professional relationships with sponsors, acquiring new business mentors, creating a comprehensive business plan, and developing a detailed student leadership structure.

**The Innovation in Control Award** celebrates an innovative control system or application of control components—electrical, mechanical, or software—to provide unique machine functions. The LigerBots won at both the district and NE Championship levels in 2016 for its robot’s adjustable-tipped ball-shooting mechanism and vision-control software.



# LigerBots Develop STEAM Activities for Kids



The LigerBots have developed hands-on STEAM activities designed to teach younger students various STEAM concepts. We research and test an activity and then pair it with an instructional flyer written and designed by our graphics students. Each flyer features the steps in the activity and teaches a different scientific concept, ranging from solar power to Newton's laws of motion.

As soon as we had a few activities ready, we began to take them to community events along with our demo robot, and to host STEAM fairs for elementary schools, libraries, and other organizations. We received so many requests for STEAM outreach events that we decided to make our flyers downloadable from our website, providing more accessibility. Currently we have 15 activities available, and three in development.

Our activities and flyers have not only helped us organize our STEAM outreach, but also have been a key part of our FIRST LEGO League involvement. We host an annual "FLL Info Night" to encourage the creation of new FLL teams in our area. During the info night we set up STEAM activities for students while parents listen to our presentation about FIRST. We also run a STEAM expo at the LigerBots-hosted FLL MA East Championship, which includes LigerBots STEAM activities as well as demonstrations by many



Balloon car STEAM activity kit provided by the LigerBots at the 2021 FLL MA East Championship.

local businesses. Since 2018 the Newton Girl Scouts have used this STEAM expo to replace their own event in which they earn a STEM patch.

Having a large variety of STEAM activities to choose from helped solve a problem we encountered during the pandemic: finding a way to continue to run this STEAM expo while ensuring the safety of everyone attending. Instead of having our usual tables full of activities in the main hall at Newton North High School, which would have attracted unsafe crowds, we adapted some of our STEAM activities into kits for every FLL student attending the event to bring back to their pits or take home.

The LigerBots find that developing and presenting our STEAM activities not only help us educate our community but also ourselves.



LigerBot assists child with binary beads STEAM activity at Newtonville Village Day.

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## Spool Racer

*Race your friends with kinetic and potential energy!*

**Materials**

- Large thread spool
- Paper clip
- Tape
- Two toothpicks
- Thin rubber band
- Two thick rubber bands
- Small metal washer, about 1/2" in diameter

1. Straighten a paperclip, leaving a hooked end small enough to fit through the spool. Place the thin rubber band on the hook.

2. Push the paper clip's straight end through the hole in the spool. Pull the rubber band through until both ends of the band are sticking out.

3. Break one toothpick in half and thread it through the loop in the rubber band.

4. Pull the other end of the band so that the toothpick is held in place against the spool. Tape it.

5. Add tires by stretching the thick rubber bands over the raised outer edges of the spool.

6. Thread the rubber band through a washer. Thread another toothpick through the loop in the band.

7. Wind up the rubber band using the toothpick.

8. Holding the toothpick so that the rubber band doesn't unwind, put the racer on a flat surface, then let it go!

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Spool racer flyer

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## Slime

**Ingredients**

- 1.5 tsp. baking soda
- 1 Tbsp. contact lens solution that contains borax
- 4 fluid oz. Elmer's glue
- food coloring
- plastic cup or bowl
- popstick sticks for stirring

1. Pour the glue into your cup or bowl.

2. Add your choice of food coloring and mix with a popsicle stick.

3. Add the baking soda and mix again.

4. Add contact lens solution and mix until the slime gets harder to mix.

5. Take the slime out of the cup and knead it with both hands.

6. Stretch and check for consistency. If sticky, add 3/4 tsp contact lens solution.

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Slime flyer.

### The Science Behind Spool Racers

*The most important part of any car is the engine, which turns the energy stored in a source such as gasoline, electricity, or a spring, into the energy of motion. The engine of your spool racer is a rubber band, which, when stretched and twisted, becomes a combination torsion/extension spring. Let's explore the science behind your spool racer!*

#### Trick Out Your Racer!

Here are some ways to experiment with your racer:

- Replace your thin rubber band with one of a different length or thickness.
- Use a spool of a different size or material.
- Wind up your racer more or less.
- Decorate your spool!

#### Anatomy of a Spool Racer

- The larger toothpick is a crank for winding the rubber band. When you release the spool racer, the toothpick drags on the surface, preventing the rubber band from untwisting rapidly in the air. This forces the potential energy in the rubber band to be expended by rolling the spool.
- The half toothpick anchors the other end of the rubber band permanently, which also prevents the rubber band from untwisting in the air when you release your racer.
- The thin rubber band is a combination torsion/extension spring that powers your racer. It stretches *and* twists as it acquires energy when you wind it up.
- The thick rubber bands are tires that create equal friction between each side of the spool racer and the surface so that the spool rolls in a straight path.
- The washer minimizes friction between the toothpick and the spool so that the spool can turn easily as the rubber band unwinds.

#### Potential and Kinetic Energy

Energy is the ability for things to change and move. It can be the energy of an object's motion, called kinetic energy, or it can be the energy stored in an object because of its position or state, called potential energy. Think of potential energy as kinetic energy waiting to happen! Imagine a roller coaster: when it is at the top of the hill, the car has a lot of potential energy due to its height and its ability to move downward, but it has no kinetic energy (motion). As the car zooms down the hill, its potential energy is released and converted into kinetic energy. As the potential energy decreases, the kinetic energy increases. At the bottom of the hill there is no more potential energy. It has all been used up to move the car!

Kinetic Energy 0  
Potential Energy 100  
KE: 50  
PE: 50  
KE: 100  
PE: 0

*Kinetic and potential energy change places throughout the ride.*

#### Elastic Potential Energy: Springs

Elastic potential energy is potential energy stored in things that can change their shape when force is applied. When you stretch and twist a rubber band in your spool racer, you are using kinetic energy from your hand to store elastic potential energy in the rubber band. When you release the rubber band, its elastic potential energy is converted back into kinetic energy to power your spool racer. Any object that can store elastic energy can be called a spring. The most common types of human-made springs are compression springs, extension springs, and torsion springs, often in the shape of coils.

##### Compression Springs

*Compression springs acquire energy when they're compressed to make them smaller. They release their energy by getting bigger in order to return to their original shape.*

##### Extension Springs

*Extension springs acquire energy when they're pulled to make them bigger. They release their energy by getting smaller in order to return to their original shape.*

##### Torsion Springs

*Torsion springs acquire energy by being twisted. They release their energy by untwisting in order to return to their original shape.*

### Slime Activities

- Confirm that your slime is a liquid.** Put your slime into three or more containers with different shapes. Observe how the slime moves around and takes the shape of its new container.
- Test and change the viscosity of your slime.** Observe the rate at which the slime stretches towards the table when you hold it up high and let gravity pull it towards the ground. See if you can figure out how to make it more stretchy or more bouncy by adding more baking soda or more contact lens solution. Add a few drops of contact lens solution (acidic) and observe how your slime becomes more liquid. Then add a little baking soda (alkaline) and observe how the slime becomes more viscous again.
- Test the response of your slime to "shear force."** Drop your slime onto a hard, smooth surface (like a floor or table) from high up to see how much it bounces from different heights. Slowly squish it onto the surface with the palm of your hand with varying degrees of force to see how it gets harder or easier to spread. Rip your slime abruptly into two pieces to observe how it tears.

### The Science Behind Slime

Slime is a cross-linked polymer. It is made from the reaction between glue containing long-chain polyvinyl acetate molecules and contact solution containing borax.

The molecules in glue look like strands of spaghetti. These molecules can slide past each other only with difficulty, so the glue doesn't gush from the bottle, it has to be squeezed out. Borate ions in the contact solution react to link the long glue molecules to each other, making even bigger molecules. The strands of spaghetti become one big mass that we know and love as slime.

The cross-linked polymer traps a lot of water, so slime is wet. You can adjust the consistency of slime by controlling the ratio of glue to borax and baking soda. If you have more glue, the slime will be more liquid (less viscous.) If you have more borax or baking soda, the slime will be more solid (more viscous.)

Slime thickens with force, but breaks when torn. Slime is a "shear thickening" fluid, meaning that the more force that is applied to it the thicker (more viscous) it becomes. If you drop slime it acts like a solid and bounces, but if you slowly squish slime it acts like a liquid and stretches. However, if you tear slime apart it will break abruptly. Squishing allows the cross-links to break and re-form, but tearing severs the cross-links between the molecules faster than the connections can re-form.

Here is some chemistry, for more advanced understanding:

- Adding baking soda (sodium bicarbonate) to glue increases the speed of (catalyzes) the reaction between the polyvinyl acetate and the water in the glue. This reaction creates polyvinyl alcohol.
- The contact lens solution contains borate ions, created in several chemical steps when borax is mixed with water at the contact lens solution factory.
  - Borax + water = sodium ions + tetraborate ions.
  - Tetraborate ions + water = boric acid.
  - Boric acid + water = borate ions + hydrogen ions.
- Each borate ion reacts with two polyvinyl alcohol chains, linking them so they can't easily move. (This is called "cross linking.") The more cross links the slime has, the more solid it is.

Line structure of a polyvinyl acetate monomer.

Ball-and-stick model of polyvinyl acetate.



# LigerBots Promote FIRST LEGO League



In 2015, the LigerBots hosted an FLL competition and STEAM expo. Since 2016, the team has organized, coordinated, and staffed competitions each academic year. Feedback from FLL coaches was so positive that New England FIRST asked us to host the FLL Massachusetts East Championship last year. This year, 24 FLL teams took part in the Newton Qualifier we hosted.

In addition to our work, we also have had staffing help from FRC 246 Overclocked, Newton South High School's Science Team, and the Newton North High School Computer Programming Club, helping build relationships with other STEM programs both inside and outside of FIRST.

We measure the success of our FLL competitions in two ways: the income the competitions generate and the feedback from those who come. Our FLL competitions attract about 1700 people annually, and help us earn more than \$5,000 from a combination of food sales and team registrations. Our feedback from coaches, parents, students, and volunteers is overwhelmingly positive. One parent commented, "I just wanted to thank everyone for all their hard work making this a success. My son will definitely be back, and our

younger son is likely to participate." Another parent said, "Every single LigerBot was helpful and friendly. They did a great job of representing their team, their teachers, and their school. Well done!" One even thanked us for inspiring his kids stating "they want to be just like you."

Every year, we host an FLL info night in June to encourage the creation of more teams in Newton. We set up engaging STEAM activities, including brush-bots, LEGO towers, and binary beads bracelets, while the parents listen to an overview presentation about FIRST. We have recently facilitated the creation of three FLL teams, as well as an FLL Jr. team, bringing more than 20 families into the FIRST pipeline.

Three of our students have helped mentor the SuperNovas, a Newton-based team that was created at our FLL info night. LigerBots mentors taught the basics of programming, robot design, essay writing, and public speaking.

The LigerBots have also had a long term mentor relationship with Newton's all-girl team, the Day Dragons. In 2018, we helped the Day Dragons make it to the FLL world championship by coaching them on their project presentation.



Visitors make crayons at the LigerBots FLL Info Night.



LigerBots mentor a presentation by the Day Dragons FLL team.

Right: LigerBots team member scores the Tie-Dye Chickens in a Newton Qualifier match. Below: Second Place Robot Design Award from the 2022 Newton Qualifier.



Row 2 left to right: Astronettes compete in a Massachusetts East Championship match; award ceremony. Row 3, left to right: limbo line before an award ceremony; parents snap a photo of their FLL teams in front of the LigerBots/FLL backdrop.





**LIGERBOTS STEAM EXPOS ARE ENGAGING**



Row 1: Brandeis MakerLab; LigerBots slime; LigerBots Outreach robot. Row 2: LigerBots PB&J robot (top); Star Wars 501st Legion (bottom); LigerBots slime; R2 Builders. Row 3: LigerBots 3D printer; Empow Studios.

**AT OUR FLL TOURNAMENTS, LIGERBOTS FILL MANY ROLES**



Row 1: judging for FLL Jr.; refereeing. Row 2: selling food; staffing safety desk and lost and found. Row 3: Emcee'ing; resetting game table; running audiovisual.



# LigerBots Help Bring Girls into STEM Fields



We train LigerBots members to share their STEAM knowledge in a way that everyone can understand. All of our FLL competitions include a STEAM expo (Science, Technology, Engineering, Art and Math) that brings in outside organizations to share their knowledge with the community. We are especially interested in helping achieve gender balance in STEM fields. Since 2018, the Newton Girl Scouts have used our event to replace their canceled STEAM fair, learning STEAM skills through activities like origami, binary beads, handling 3D printed molecule models, and “coding” our human robot.

The LigerBots also have helped put together three day-long Women In STEM events at Newton North High School to celebrate the accomplishments of women in STEM fields, with the goal of inspiring girls to pursue STEM careers. At these events, LigerBots mentors give presentations about their professional work, and student team members take a hands-on approach to organizing the event.

We also attend women in STEM events in our community, including a Zoom event hosted by Belmont High School during the pandemic and an in-person event at the Newton Free Library.

After we mentored the all-girls FLL team the Day Dragons, four of their members joined the LigerBots when they became high school freshmen, and several rose to be team leaders.

In 2023, LigerBots have 32 girls on the team, and we have normalized the idea of female build leaders. Seven out of eight of our technical groups are led by girls. Girls also lead our graphics and FIRST Impact Award submission groups.

## Exhibitors at Our Recent FLL STEAM Expos

- Brandeis Maker Lab
- Code Ninjas
- Einstein's Workshop
- Empow Studios
- Gamewright
- Green Newton
- Hatch Makerspace
- IRobot
- Johnson String Instrument
- Made@MassChallenge
- Massachusetts National Guard
- MassBay Community College STEM
- Microsoft
- National Guard
- New Art Center
- New England Model Engineering Society
- New England Optical Association of America
- New England R2 Builders
- Newton Free Library
- Newton South Women In STEM
- NuVu
- Orimagi.io
- Prospect Hill Forge
- Rise Robotics
- Robosall
- Russian School of Math
- SharkNinja
- Society of Women Engineers
- Star Wars 501st Legion
- Students for a Greener World



Clockwise from top left: FLL Info Night; Girl Scouts at FLL MA East Championship STEAM expo; Newton's Earth Day celebration at City Hall; LigerBots mentor teaches students; LigerBots put together robot component; LigerBot shows children how to drive the robot at the Newton Pumpkin Smash.



# LigerBots Engage with Our Community



The LigerBots have three goals for our outreach: to spread the messages of FIRST; to promote project-based learning; and to give team members experience in sharing STEAM ideas with the community. Students learn to communicate the messages of FIRST by practicing giving speeches and presenting them at outreach events.

We take our project-based STEAM activities for children and informational flyers about these activities to outreach events. These include brush bots, origami, paper airplanes, slime, binary beads, spool racers, mini light sabers, and needle compasses, among others.

In typical years we run or attend an average of 28 outreach events. Even during the 2020/21 and

2021/22 academic years, which were profoundly changed by Covid-19, we averaged eight events each year. In the 2022/23 academic year, we came back strong, attending or planning to attend at least 24 events. These ranged from bigger community events like the Boston GreenFest to smaller gatherings like our visit to Boy Scout troops with our robot.

We also regularly assist with Newton Inspires, an annual fundraiser for the Newton Schools Foundation (NSF). Accomplished people in Newton come to talk and learn about the growth and innovation going on in our community. Helping with Newton Inspires helps us maintain a strong relationship with NSF, our parent organization and one of our biggest supporters.



*Newton Memorial Day parade.*



*Clockwise from top left: visit to the Field School of Weston; Boston GreenFest; MIT IDE Inclusive Innovation Awards; visit to Saint John School of Wellesley; Tour de Newton; Newton Pumpkin Smash.*



# LigerBots Do Outreach Everywhere!

## Events with LigerBots sponsors

- Whole Foods/Newton Schools Foundation fundraiser
- PTC LiveWorx
- Robo Madness, at Google
- Sponsor pitch at Fowler High Precision
- Sponsor pitch at OneShield

## LigerBots and FIRST events

- Girls + Tools Night
- FLL Info Night
- Newton FLL Qualifier + STEAM expo
- FLL MA East Championship + STEAM expo
- Mentoring FRC 6740, Glue Gun & Glitter
- Assisting Newton's Law of Mass FTC team
- Field trip to the Museum of Science and Industry

## School events

- Just Think! Expo
- Newton North and South club fairs
- Women in STEM Day at Newton North
- Newton South High School parents' night
- Newton South science department open house
- Bowen Elementary School science day
- Cabot Elementary School Invention Invasion
- Weston Field School robot demo
- St. John School Visit
- Bike Train

## Government Relations

- FIRST National Advocacy Conference
- Southern New England Advocacy Conference
- Mayoral candidate visits to our workshop

## Community events

- Newtonville and Newton Highlands village days
- Newton Inspires
- Newton/Needham Innovation District maker space talks
- Cambridge Carnival and Robot Zoo
- Newton Festival of the Arts
- Boston STEM Fair
- Pumpkin Smash
- Flag planting at Newton Veterans Memorial
- Newton Memorial Day parade
- Tour de Newton
- Newton Free Library STEAM Expo
- Newton Free Library Think Big girls' STEM event
- Talk at a retirement community
- Demo at Cub Scout meeting
- Girl Scouts STEAM patch workshop
- Girl Up Boston Coalition Steminist Saturday
- Boston Greenfest
- Cambridge Science Fair
- Green-Expo

## Tech events

- Electronic Components Industry Association events
- MA STEM Summit
- Robotica
- Robo Madness
- RoboBoston
- From Global to Local MIT education conference
- MIT IDE Inclusive Innovation Awards
- MIT Blueprint high school hackathon



Clockwise from top left: Newton Pumpkin Smash; Newtonville Village Day, St. John School, Wellesley, Burr Elementary School STEAM fair; Bowen Elementary School bike rodeo; Newtonville Village Day.



LIGERBOTS

FIRST Robotics Team 2877

Newton North and South High Schools



140 Brandeis Road, Newton Centre, MA 02459

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#FRC2877 ■ The LigerBots

@ligerbots ■ @ligerbots\_frc2877

About the LigerBots

The LigerBots is FIRST Robotics Competition (FRC) team 2877. FIRST (“For Inspiration and Recognition of Science and Technology”) is an international organizer of competitive robotics events whose mission is to lead students toward careers in science, technology, engineering and mathematics (STEM). The LigerBots is a non-profit organization that provides students with the skills they need to prepare for the jobs of the future and become the next generation of engineers and business people. The team combines students from Newton North and Newton South high schools to spread the message of STEM education in the community and help students develop their problem solving and critical thinking skills while they pursue their interests in business and robotics.

LigerBots do intensive technical and outreach training each fall, and have six weeks each winter to build a 120-lb. robot that can compete in the spring in a new game designed by FIRST each year. The LigerBots pride ourselves on our dedicated student leadership infrastructure and variety of mentors, who include scientists, engineers, programmers, marketers, publicists, financial consultants, project managers, and graphic designers. The team’s ability to offer these opportunities to high school students is dependent on its generous sponsors. The LigerBots is always looking for new sponsors and donors to help sustain the team. Major sponsors are identified on all LigerBots materials, including marketing documents, the competition pit, the website, and the robot itself.

Sponsor or donate to the LigerBots: info@ligerbots.org, www.ligerbots.org



LigerBots at the 2022 New England FIRST District Championship.



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Check out our team sponsors!  
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LIGERBOTS

FIRST Robotics Team 2877

Newton North and South High Schools



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#FRC2877 ■ The LigerBots

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Be a LigerBot, Mentor a LigerBot

Who is on Our Team

- We are composed of students from Newton North and Newton South high schools.
- We have adult mentors and coaches, including parents of team members and other STEM and business professionals. We are always looking for adult mentors who have expertise in mechanical and electrical engineering, programming, marketing, publicity, finance, project management, and graphics.

Our Role in FIRST Robotics

- We design and build a robot with a different function every year, and participate in two to four FIRST competitions.
- We have made it four times to the FIRST World Championship.
- We organize the Newton FLL Qualifier and the Eastern MA FLL State Championship for elementary and middle school students, and we mentor FLL teams.



LigerBot and mentor work on mock playing field elements.

FIRST Opportunities for Younger Students

- FIRST Lego League (FLL) is robotics for students in grades 4 – 8. Email: flf@ligerbots.org
- FIRST Lego League Jr. is for students in grades 1 – 3. Website: www.juniorfirstlegoleague.org

Be a LigerBot, mentor a LigerBot: info@ligerbots.org, www.ligerbots.org



The drive team with Prometheus, the LigerBots 2022 robot.

The Engineering and Business Skills We Learn


- |                            |                    |                   |
|----------------------------|--------------------|-------------------|
| ■ Mechanical engineering   | ■ Entrepreneurship | ■ Mentorship      |
| ■ Electrical engineering   | ■ Finance          | ■ Public speaking |
| ■ Programming              | ■ Project planning | ■ Graphic design  |
| ■ Computer Aided Design    | ■ Leadership       | ■ Writing         |
| ■ Gracious Professionalism | ■ Teamwork         | ■ Photography     |

The Rhythm of Our Year

- Fall and late spring: Pre- and post-season. We plan projects, do team-building, technical training, fundraising, and STEAM outreach. Team meetings at Newton North High School on Mondays 6:30 p.m., and at Newton South High School on Thursdays at 6:30 p.m.
- Winter: “Build” season. We design and build a robot from Jan. – Feb. Meetings Mon. – Sat. at Newton South High School
- Spring: Competition season. We compete against other FIRST Robotics teams with our robot, weekends in March and April.



# LigerBots Awesome Mentorship Program

 As businesses closed, schools shut down, and life came to a sudden and shocking halt in March of 2020 due to Covid-19, the LigerBots came up with an idea to run a distance-learning program that paired elementary school students with high school students so they could do activities together. We felt this would help both the high school students looking for volunteer opportunities and elementary school students bored at home. We called this project the Awesome Mentorship Program (AMP).

After the success of our spring program, we decided to develop a summer camp based on AMP, cAMP. cAMP ran for three two-week sessions, and by the end of August the AMP and cAMP programs had connected more than 200 elementary school students with 100 high school volunteers. To share our experience, we wrote a white paper about cAMP that was featured in the *Boston Globe*!

To find mentees, we promoted the program through the NewtonSTEM.org newsletter and the Newton Parents Facebook group. To find interested mentors, we made social media ads, persuaded friend groups to share the program through word-of-mouth, and promoted the program through high school vice principals. Non-LigerBots students went through a vetting process to determine if the mentors were responsible and enthusiastic. Once paired, the students worked together remotely on many different activities, including science experiments like elephant toothpaste, programming through Scratch, and playing Minecraft.

To support the mentors, LigerBots hosted mentor training sessions, created a mentor manual with activity suggestions, and made a Discord server to help mentors support each other and play Minecraft together with mentees.

As we developed our AMP program, our team members quickly became expert project planners and troubleshooters. In order to create schedules that would make both campers and counselors happy, we

## Some Classes Offered During cAMP

- Song writing
- Undersea exploration
- Greek mythology
- Dungeons and Dragons
- TV media
- Mythical creatures
- Spaceflight, rocketry, and astronomy
- Climate and environmental science
- Thematic map making
- Pencil code

spent 100 hours creating a custom Google Sheet script. When we had trouble getting materials to campers, we came up with a distribution system that involved parent pick-up from a central location. When certain campers needed extra help or space, we came up with Zoom quiet breakout rooms and counselors dedicated to assisting special-needs students.

But the biggest challenge was creating a fun, safe, and engaging community despite being in a remote environment. Kahoot, ice breakers, and cAMP-branded shirts that were sold to counselors and campers helped create a sense of community. Constructing smaller groups that worked together on projects was also key; keeping these groups small sparked conversations and built trust. A final showcase ended each two week session and provided a final bonding event for a community that had already become quite close.

Despite the giant undertaking, cAMP and AMP provided a wonderful experience for our student administrators, mentors, counselors, and campers. Administrators and counselors left with an appreciation for the difficulties their own teachers faced when teaching remotely, and campers received the close knit community they needed during the pandemic.




	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 - 9:25	Morning Meeting	Morning Meeting	Morning Meeting	Morning Meeting	Morning Meeting
9:25 - 10:20	Activity A	Activity B	Activity A	Activity B	Activity A
10:20 - 10:30	Break time	Break time	Break time	Break time	Break time
10:30 - 11:25	Activity B	Activity D	Activity C	Activity C	Activity D
11:25 - 11:35	Break time	Break time	Break time	Break time	Break time
11:35 - 12:30	Activity C	Activity E	Activity D	Activity E	Activity E

	Monday
9:00 - 9:25	Morning Meeting
9:25 - 10:20	Math - Eric Y & Karen T
	Science - Idan M & Belle S(TA)
	Geography - Alex K
	Reading - Danielle B & Giuliana R
	Biology - Henry C
10:20 - 10:30	Thematic Mapmaking - Zoe K
	Break time
	Dance - Kat M & Natasha L
	Math - Audrey K & Abby Z
	Math - Tal E & Michael-David N
10:30 - 11:25	English - Scott P
	Creative Writing - Avery W
	Math - Ruchik T
	Break time
	Art - Rebecca Y & Nicole W
11:25 - 11:35	Mythical Creatures- Claudia & Anson
	Science - Sebastian Y & Asa Z
	Math - Jolie L
	Greek Mythology - Rose G
	Engineering - Tony F

### Newton high school robotics team cracks the code for making virtual learning fun

By Kami Rieck Boston University journalist, Updated October 7, 2020, 2 hours ago



High schoolers launched Camp AMP in the summer after the Newton LigerBots high-school robotics team noticed how COVID-19 impacted elementary school students and parents. CONTRIBUTED PHOTO

To ease the transition to hybrid and remote learning for students and teachers, Newton's high school robotics team spent much of their summer running a free, virtual camp for elementary school students. What they've learned, they said, could help teachers in the age of distance learning.

### THIS FALL

Virtually mentor and tutor elementary students!

### High Schoolers

Build mentorship and communication skills through tutoring, teaching, and more!

Sign Up!  
<https://tinyurl.com/FallAMPmentor>



AMP  
Awesome Mentorship Project



Clockwise from top left: camper showing painting to the camera; cAMP-branded t-shirt; Monday schedule from session three master schedule; Instagram ad advertising AMP Fall 2020; beginning of the Boston Globe article about cAMP; weekly schedule for all sessions.



# LigerBots Connect with Our Government



We connect regularly with government officials to advocate for our team and for STEM learning.

During the Newton mayoral election in 2016 the LigerBots workshop became a stop on every candidate's campaign trail. Newton Mayor Ruthanne Fuller became a LigerBots fan, driving our robot at outreach events and inviting us to her office to celebrate a successful season. We regularly email with members of the city council and also take part in community events such as the annual Memorial Day parade.

Our influence reaches Beacon Hill and Capitol Hill. We met with Massachusetts state senator Cynthia Creem, and with state representatives John Lawn, Kay Khan, and Ruth Balser.

At the federal level, we played a crucial part in passing Act H. R.500, which directs the Department of the Treasury to mint and issue 350,000 \$1 silver coins in commemoration of Space Shuttle Challenger astronaut Christa McAuliffe. In the summer of 2018 we worked with 25 teams at the FIRST National Advocacy Conference in Washington D.C., advocating

successfully for the reauthorization of the Perkins Act, as well as for fully funding the allocation for the Every Student Succeeds Act. These provide funding for STEM education in schools around the country. We lobbied the offices of Senator Warren, Senator Markey, and Representative Capuano, and talked directly to Representative Kennedy.

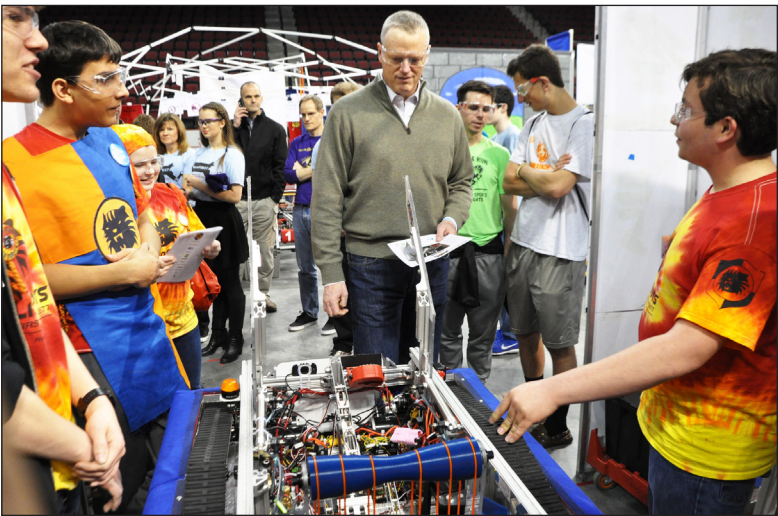
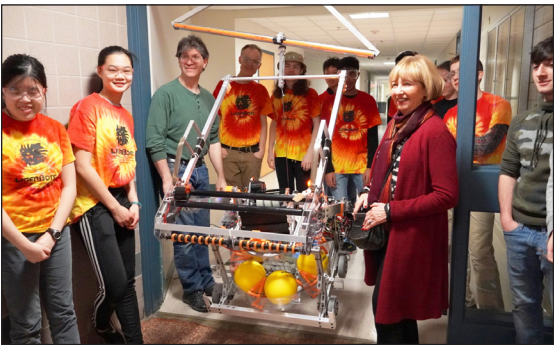
As active members of the FIRST Southern New England Advocacy Conference we contributed to the effort to pass Massachusetts Amendment #238, which would have given FIRST teams 250k total in Massachusetts state funds.

Our elected officials share in our successes. Newton School committee member Matthew Miller responded to our FIRST safety animation award, "Your video was well done, and the execution was insanely creative. I have always been a huge LigerBots fan. Keep on making Newton proud. You all ROCK!!!"

From training to FLL, everything we embark on ensures that the LigerBots remain the core of project-based learning in Newton and an advocate for STEM throughout the country.



FIRST Robotics teams at the 2018 National STEM Advocacy Conference in Washington, D.C. The LigerBots are at the left in the middle of the group.



Clockwise from top: with MA representative Joe Kennedy, III at the 2018 National STEM Advocacy Conference in Washington, D.C.; Massachusetts state senator Cynthia Creem views our 2020 robot in our workshop; Newton mayor Ruthanne Fuller drives the LigerBots robot at the Just Think Expo; Massachusetts governor Charlie Baker gets an explanation the LigerBots pit during a Boston University FRC competition; with Massachusetts state representative Ruth Balser at the Massachusetts State House during the FIRST 2019 Southern New England Advocacy Conference.



# LigerBots Are in the Public Media

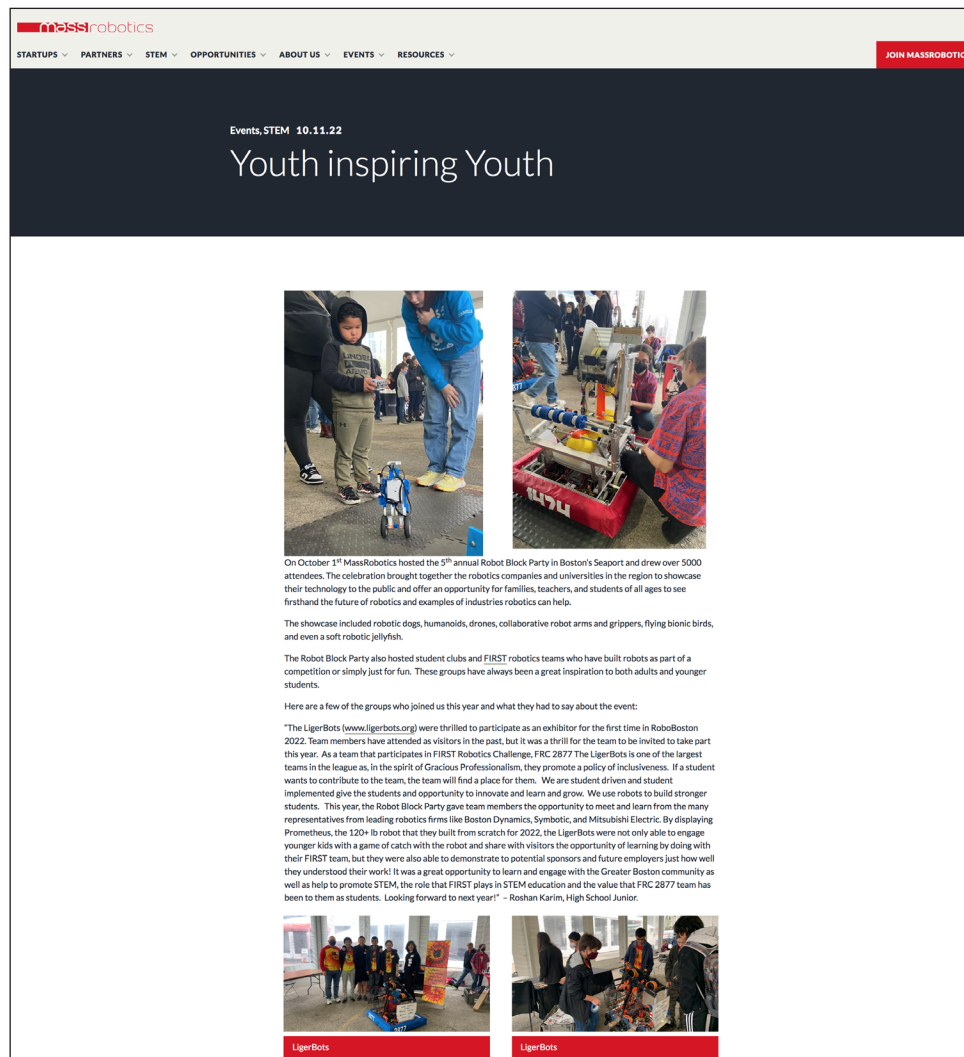
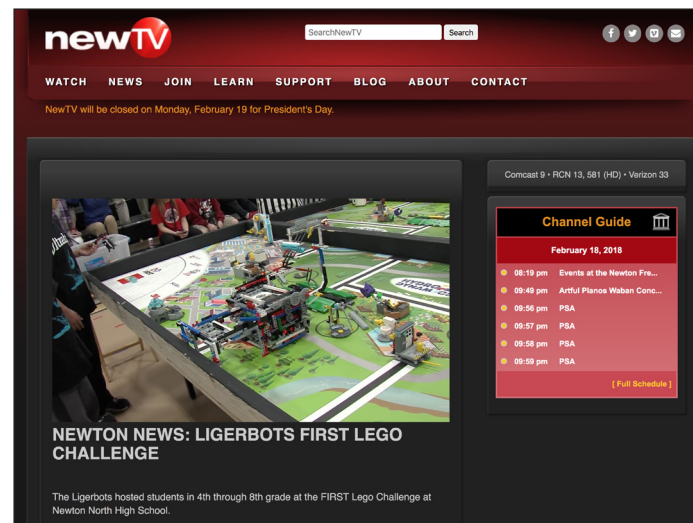


LigerBots train our team members in how publicize team activities and events by practicing “elevator pitches” about the team, learning how to interview and be interviewed, and how to write press releases and blog posts.

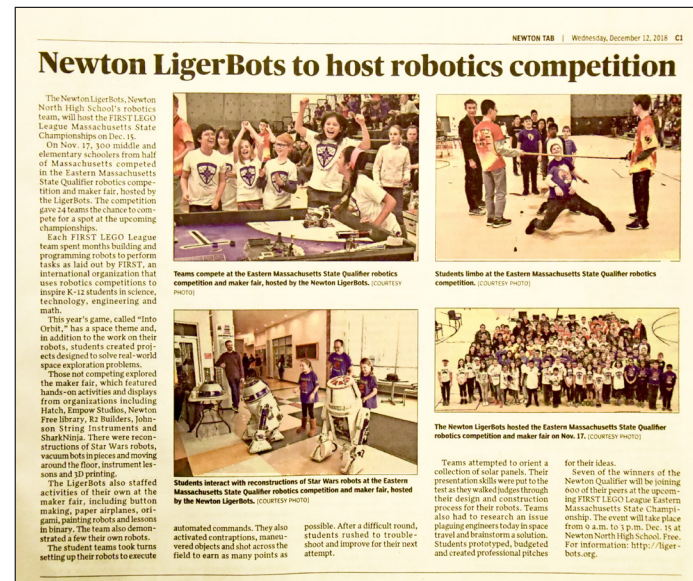
LigerBots has been featured in the in the *Boston Globe* and and in the *Newton TAB*. The NewtonSTEM.org newsletter has posted more than 85 articles about the team since 2015. We have also been interviewed by TES, one of the largest teacher

publications in the world. We maintain regular updates on social media channels and our website blog.

In 2022 the LigerBots started a public blog about our robot build progress on the Open Alliance, a section of the FIRST Robotics discussion form Chief Delphi that is intended to help FIRST Robotics teams share their ideas openly. By publishing CAD, pictures, videos, and documentation, we help other teams learn from our accomplishments and setbacks. Our blog has been viewed more than 7,300 times.




MassRobotics blog post about LigerBots attending the annual Robot Block Party.



Clockwise from upper left: NewTV reporter interviews LigerBots at Just Think Expo; story about the FIRST LEGO League E. MA Championship on the NewtonSTEM.org website; David Pogue of PBS series NOVA interviews LigerBots at the PTC LiveWorx conference; LigerBots in the Newton TAB; NewTV story about the FLL MA East Championship.







# LIGERBOTS FIRST

## Robotics Team 2877


Newton North and South High Schools • Newton, Massachusetts



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### LIGERBOTS BLOG



Are you a Newton public high school student who is interested in entrepreneurship, leadership, or robotics? The LigerBots are a joint Newton North/Newton South FIRST Robotics Competition (FRC) team. The team offers training and hands-on...

[Read More >>](#)

### UPCOMING EVENTS

Monday, February 14	6:30pm Team Meeting (South)
Tuesday, February 15	6:30pm Team Meeting (South)
Wednesday, February 16	6:30pm Team Meeting (South)
Thursday, February 17	6:30pm Team Meeting (South)
Friday, February 18	6:00pm Team Meeting (South)
Saturday, February 19	6:00pm Team Meeting (South)
Sunday, February 20	6:00pm Team Meeting (South)
Monday, February 21	6:30pm Team Meeting (South)
Tuesday, February 22	6:30pm Team Meeting (South)
Wednesday, February 23	6:30pm Team Meeting (South)
Thursday, February 24	6:30pm Team Meeting (South)
Friday, February 25	6:00pm Team Meeting (South)
Saturday, February 26	6:00pm Team Meeting (South)
Sunday, February 27	6:00pm Team Meeting (South)
Monday, February 28	6:30pm Team Meeting (South)
Tuesday, March 1	6:30pm Team Meeting (South)
Wednesday, March 2	6:30pm Team Meeting (South)
Thursday, March 3	6:30pm Team Meeting (South)

Events shown in this zone: Eastern Time - New York

### ANNOUNCEMENTS

**Calling all hackers!**

March 12, 2021

Do you have students who are creative and like problem-solving? Programming is a great way to combine storytelling and problem solving, especially when using Scratch. ... Continue reading "Calling all hackers!"

**Join the LigerBots**

September 26, 2020

If you are interested in joining the LigerBots, please fill out the form at [ligerbots.org/join](#). We will send you the information to attend our semi-weekly meetings on Zoom. The LigerBots has opportunities for Newton High. ... Continue reading "Join the LigerBots"

**FLI Information Night Aug. 24**

August 16, 2020


The LigerBots will be hosting its annual FIRST® LEGO® League (FLI) information night online on August 24, 2020, at 8 PM. If you would like to attend — or cannot attend but be interested — ... Continue reading "FLI Information Night Aug. 24"

**Today's Meeting at Newton North**

September 19, 2019

Because of Back to School Nights at Newton South, today's LigerBots meeting will be at North, in the Engineering Rooms (normal rooms).

### TWITTER

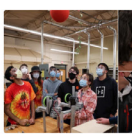


The LigerBots


BUILD SEASON PICTURES!!!

After completing our 3-day design groups for FRC, we finally begin the building process!! We are EXCITED! 🤖

#IFIRST #robots #mgmrobots #ligerbots #wow #bulldseason #2022




jan 26, 2022




The LigerBots







HAPPY 2022 🎉🎉🎉 EVERYONE!! The January 8th kickoff is approaching, and we are all super excited to get started on build season!!







#2022 #happynewyear #bulldseason #ligerbots #robots

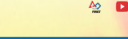









The LigerBots











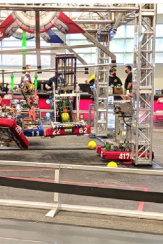
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## Keeping Busy During The Summer!

August 12, 2021



The LigerBots have been keeping busy during the 2021 off season! The team is working on a number of projects, and we have participated in multiple events in the past few weeks.

On July 27th, two LigerBots representatives toured the facilities of a local robotics company called Barrett Technology with their CEO, Bill Townsend. The company creates advanced robotic instruments like BURT, a machine which aids patients who are recovering from brain damage.




## ligerbots\_frc2877

193 posts 810 followers 460 following

**The LigerBots**  
Nonprofit organization

FRC team #2877 from Newton, MA. [We](#) [follow](#) our Facebook (the LigerBots) and Twitter (@ligerbots) for updates.

SIGN UP TO BE A MENTOR FOR AMP FAL [docs.google.com/forms/d/e/1FAIpQLSe4bPOLsbtpPQZAMGx7BKAS2ghaF-Qk...](#)



Informed...



Women's ...



stormigers



the shop



sponsor us!




DCMP @w...

POSTS

HAPPY NEW YEARS!



FROM THE LIGERBOTS!





Join us at  
**Pumpkin Smash!**


Plus hands-on activities!  
Sat. Nov. 6, 7-9, Newton City Hall




**FLL Info Night**  
Parents of Students Grades K-8  
Nov. 11th 6:00-7:00pm  
Informational! Learn, Meeting  
Saturday, Oct. 9, 7:30 p.m.  
Please fill out this form  
[https://www.fll.org/registration](#)









## The LigerBots

@LigerBots · Nonprofit organization


[Learn more](#)
[ligerbots.org](#)


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### About


[See all](#)


- Newton's award-winning, competitive FRC (FIRST Robotics Competition) team (FRC 2877), NNHS & NSHS students are mentored on Business and Technical proj. [See more](#)
- The LigerBots are a FIRST Robotics competition team made up of students from both Newton North and Newton South High Schools. The team has a diverse gr... [See more](#)


 337 people like this

 382 people follow this


 <https://ligerbots.org/>




 [info@ligerbots.com](mailto:info@ligerbots.com)


 Nonprofit Organization



The LigerBots updated their cover photo.  
50 mins · 🌐



 Like
  Comment
  Share



**The LigerBots**  
January 20 at 7:51 PM · 🌐


**BUILD SEASON PICTURES!!**

After completing our 3-day-design groups for FRC, we finally begin the building process!! We are EXCITED!! 🤗

[#ligerbots](#) [#robots](#) [#frc](#) [#mrobotbots](#) [#buildseason](#) [#wow](#) [#twentytwentytwo](#) [#FIRST](#)

### Photos

[See all](#)







Follow

## The LigerBots

@LigerBots

FRC team #2877 from Newton, MA  Follow our Facebook (the LigerBots) and Instagram (ligerbots\_frc2877) for updates. Check out our website for more info 

 Newton, MA
  [ligerbots.org](http://ligerbots.org)
 Joined April 2009

875 Following 1,023 Followers

Tweets

Tweets & replies

Media

Likes



**The LigerBots** @LigerBots · Jan 20

BUILD SEASON PICTURES!!!

After completing our 3-day-design groups for FRC, we finally begin the building process! We are EXCITED!! 🥳🥳

#FIRST #robots #omgrobots #ligerbots #wow #buildseason #2022



## New to Twitter?

Sign up now to get your own personalized timeline!

 Sign up with Google

 Sign up with Apple

Sign up with phone or email

By signing up, you agree to the [Terms of Service](#) and [Privacy Policy](#), including [Cookie Use](#).



## You might like



**Team MAX 1071**

@FRC1071

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**FIRST Team 230**

@Gaelhawks230

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**Killer Bees FRC 33**

@FRC33

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## What's happening

Super Bowl LVI · LIVE


Super Bowl LVI: Rams vs.



43



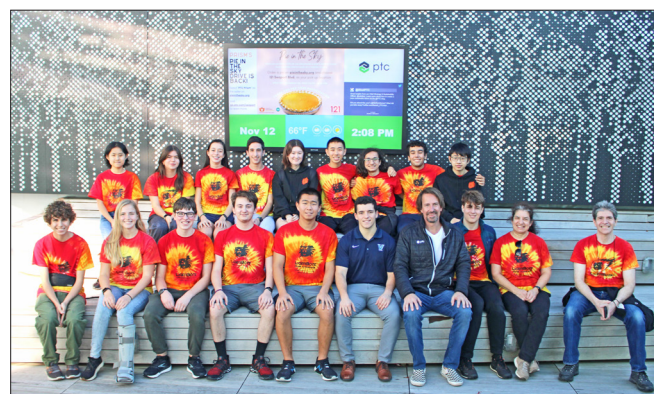
# LigerBots Connect with Our Sponsors

 In order to sustain our robotics ventures, our extra projects, and outreach events, the LigerBots rely on support from our sponsors. We train students, both business-focused and technical-focused, on how to build and manage sponsor relationships. We run an annual training session in making a brief “elevator pitch” about the team. And we write a monthly supporter update with detailed descriptions of team activities over the past month, complete with photos of these activities.

An important part of our sponsor relations is students having direct relationships with individual sponsors. This involves both emailing contacts and giving pitches face-to-face.




LigerBot practices her elevator pitches with another team member.



LigerBots visit our sponsor PTC.





LigerBots after a presentation at the Newton Rotary Club.



Dear LigerBots Supporter,

November saw the LigerBots hosting one of our most exciting events of the year, the [FIRST LEGO League \(FLL\) Newton Qualifier](#) robotics competition and maker fair—a mashup of sporting event, science fair, family reunion, and dance party! About 300 competitors, spectators and members of the public attended the event at Newton North High School, as 23 teams of students in grades four to eight competed with their LEGO robots in this year's space-exploration-themed FLL game, called “[Into Orbit](#).” The teams also displayed research projects on space-based themes.

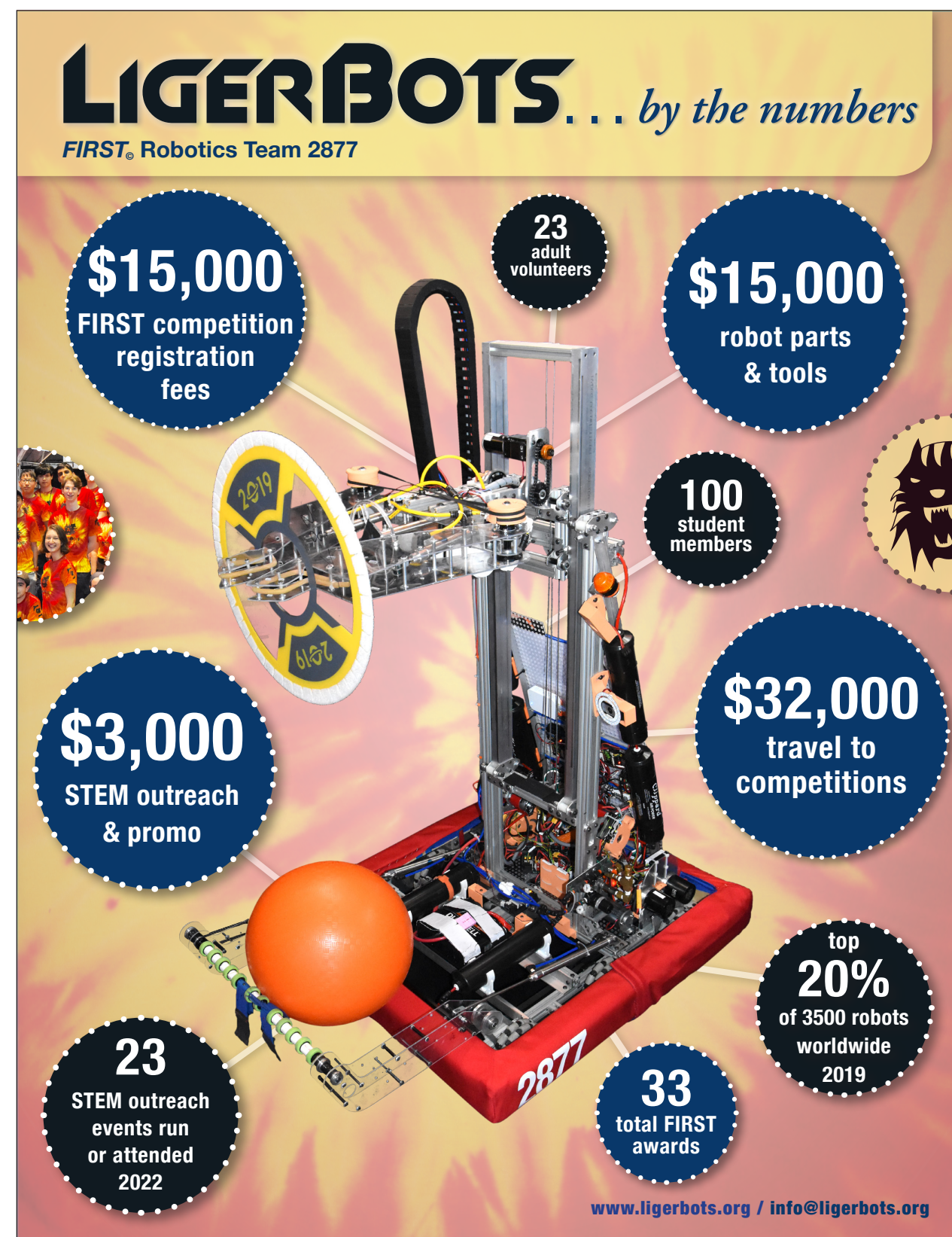




Clockwise from upper left: LigerBots-mentored team the Supernovas react to their robot's progress; the LazerRobotics drive team waits for referee Jeffrey's verdict on their points earned; the Day Dragons collect an award from the judges; the competing teams with the LigerBots; some of the Brattle Street Bobcats with their Into Orbit project

Supporter update sent via MailChimp.

## LIGERBOTS FUNDRAISING INFOGRAPHIC



This infographic shows team fundraising needs in a year we go to the FRC world championship.







# LigerBots Fund Our Activities

## 2021/22 Estimated Revenue

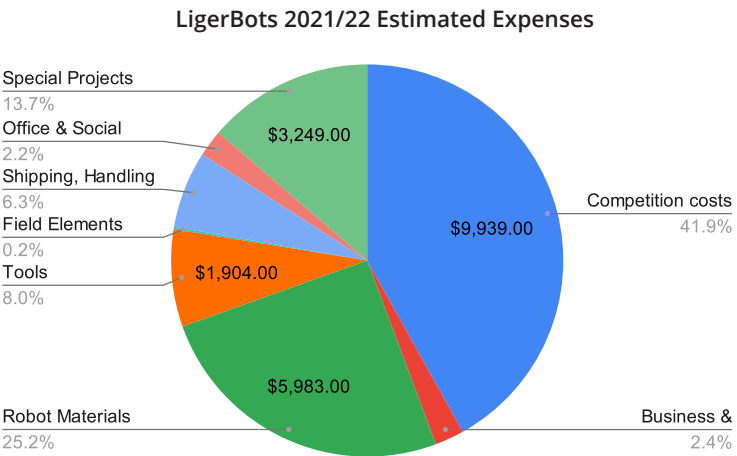
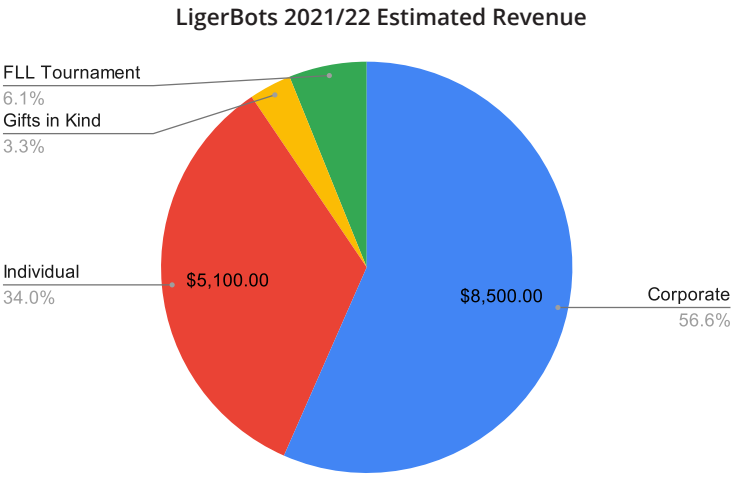
Corporate sponsorships	\$8,000
Individual donations	5,100
In-kind donations	500
FLL tournament net income	920
Transfer from team reserves	\$8701
Total revenue	\$15,020
Total expenses	\$23,721
Net income	\$0

## 2021/22 Estimated Expenses

Competition costs	\$9,939
Business & marketing	571
Robot materials	5983
Tools	1,904
Field elements	48
Shipping, handling, tax	1506
Office & social	521
Special projects	3249
Total estimated expenses	\$23,721

## 2021/22 Special Projects Details

IT	\$479
CNC upgrade	2115
Major tools	474
Coach discretionary	181
Total special projects	\$3249



Purchasing Report				Activity Codes				Purchasing Report			
Purchase Date: 12/20/2018				HOLDS				LB19-0021			
Vendor Information				Robot Materials and Parts				No. of Items: 15			
Name: McMaster-Carr				Mechanisms & Chassis Dev't				Total Quantity: 57			
Address				Field Elements				Est'd Parts Cost: \$408.89			
Phone				Marketing and Business				Approval Date: 12/20/2018			
Web Site				P.L.L.				Actual Parts Cost: \$408.89			
				Social				Total Cost: \$443.63			
				Office and Administration				Purchase Date: 12/20/2018			
Requester Information				Competition Expenses				When complete please notify			
Name				Special Projects				Igor Tempermeister			
Team Member: Asa Zeren				NOT TO EXCEED				xxx-xxx-xxxx			
Coach/Manager: Igor Tempere											

A LigerBots purchase order.

## Our Finances in 2021/22

Due to the effects of COVID and the difficult economic climate, it was a challenging year for sponsorships and grants in 2021/22, and we didn't hold our usual FLL tournaments, which bring in substantial revenue. However, because the LigerBots have been careful to build up our rainy day fund, we were able to support our programs with near normal expenditures.

## Our Financial Plan

The team supports its activities via corporate sponsorships, individual contributions, and operating FLL competitions. We also apply for, and have received funding from the Newton Public Schools for competitions at the district level and beyond.

## Our Special Projects

We seek to fund a budget beyond the base requirement of competition fees and robot parts. Special projects, which are funded through a "mini-grant" process, let team members develop financial skills while working on challenging and engaging projects. Any student or mentor can propose a special project. Some of our recent special projects have been:

- **Scouting tablets:** Purchased tablets to be used during competition to track the performance of other teams.
- **Mars rover:** Built a model Mars rover as an aid to learning basic design and manufacturing strategies.
- **Swerve drive:** Built a swerve drive train as student training project.
- **Vision project:** Assessed multiple cameras and processors to determine what will work best for robot vision during competition.
- **Provisional patent application:** Filed a provisional patent for a non-auditory whistle.
- **CNC mill:** Built a new CNC router to increase speed of cutting metal and polycarbonate plates.
- **Pneumatic test bench:** Built a test bench to help us prototype pneumatic mechanisms.

## Managing the Budget

Our team treasurer reports weekly to the coaches and execs. Sponsorship proposals and revenue are tracked by the fundraising team. Our purchasing system allows team members to specify items for purchase and approval and our Treasurer to easily track spending. Purchase orders are shared on Slack so the entire team sees and can participate in purchasing decisions. Financial operations are overseen by our financial mentor and one of the head coaches.



Our financial mentor works with a team member on the budget.

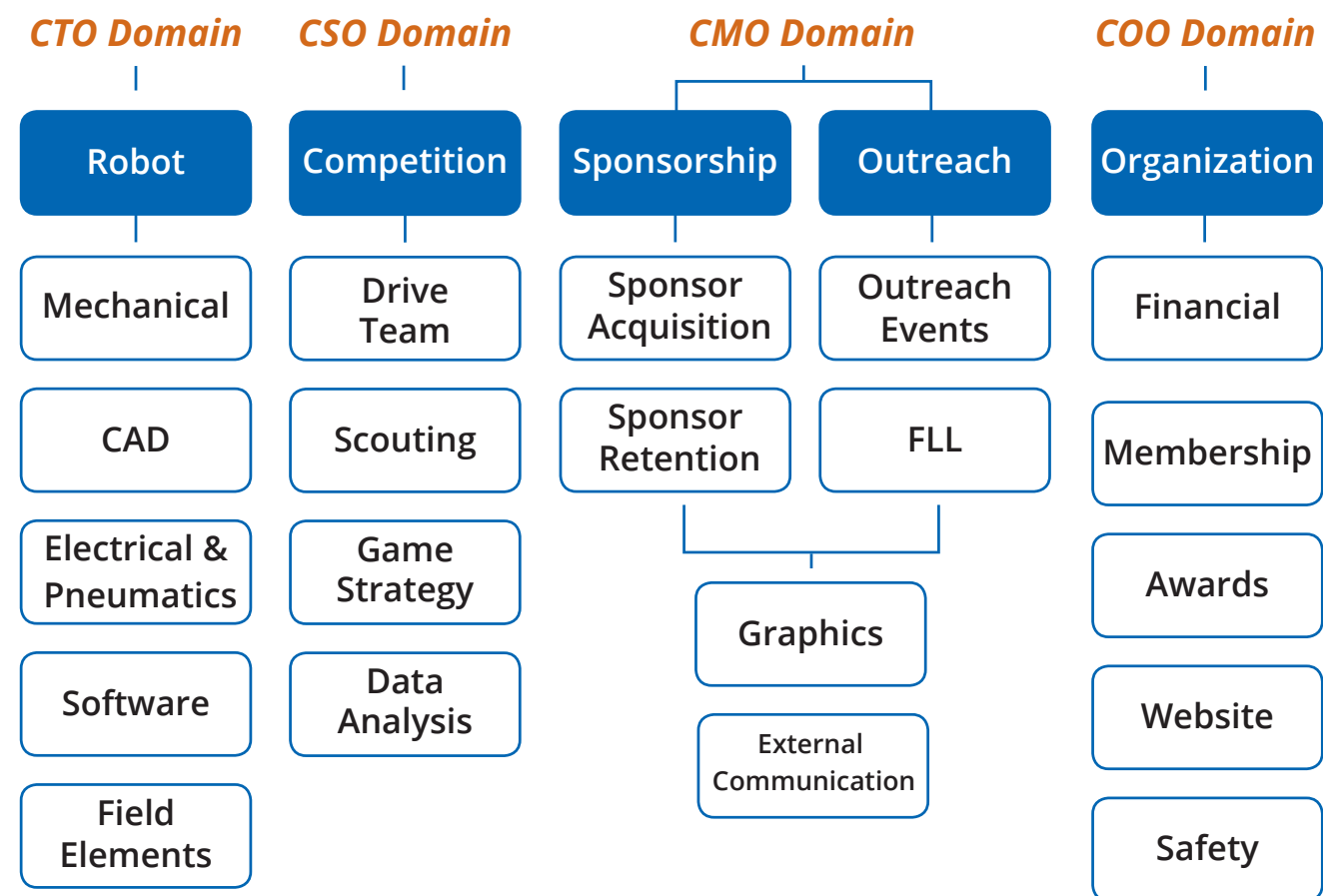
Grant Number	GR20-001	Budget \$	\$400
Name	AJ Chau	Date	January 10
Title	Scouting Tablets (x7)		
Grant summary (what do you want to do and why):			
We would like to use tablets for electronic scouting. This year half of the scouting alliance has stated that they would prefer electronic scouting. 1100 (T-hawks) has a lot of experience with these and will be at our first event (Northern CT) to help guide us through their usage, although hopefully we can figure it out ourselves. They use the same tablets, and are developing the scouting app. The tablets will also likely have other potential uses outside of scouting.			
Timeline (how long will it take and/or when will it happen):			
Longest shipping time looks to be the tablet case, at just under 2 weeks. We would like to have these a week or two before competition.			
Personnel (who will do the work)			
Daniel, AJ, Amanda, Matthew, Charlotte, Michelle			
Other considerations (equipment, space, transportation, safety, etc)			
We need a minimum of 6 tablets to scout. The 7th is for the head scout, and will also serve as a last resort backup. We're also going to need a large battery pack to last an entire scouting day. Cases and screen protectors will also probably be a good idea, if we end up using them extensively. Also shipping may not be free. We also want a sharpie since we can't find the silver one anymore (we use the black sticky notes)			

Budget	\$400	Project total	\$385.27
Item	Quantity	Unit price	Item total
Tablets	7	\$39.99	\$279.93
Battery Pack	1	\$29.95	\$29.95
Tablet Case	7	\$4.49	\$31.43
Glass Screen	3	\$9.99	\$29.97

A LigerBots mini grant proposal for tablets to be used when scouting other teams at competitions.



# LigerBots Student Leadership Structure



Team gifts at awards night.

# How I Use My LigerBots Skills Out in the World



*"I learned to communicate more clearly and concisely while working with younger students and developed pitching skills at outreach events. I also improved my organizational skills by managing team-branded items."*

—AUSTIN



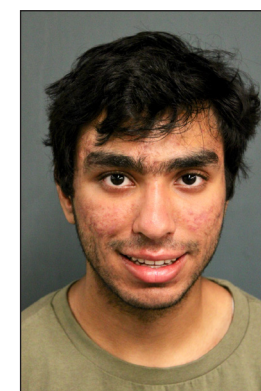
*"Building and designing robots has helped me a lot in physics and math courses, and helping to staff our FLL tournament has allowed me to gain better time management skills and be more organized."*

—CHARLOTTE



*"As a graphic designer for LigerBots, I learned about everything from professional design software, to the printing process, to project management, and have used that experience to help my mom create marketing materials for her real estate business."*

—EMILY



*"I learned professional writing skills at LigerBots, and I applied them to my college writing, which made my essay a more powerful and convincing piece."*

—KAVIN



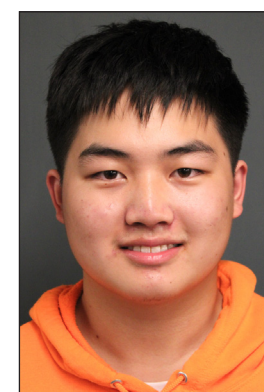
*"I used the non-profit management experience I gained on LigerBots to start my own organization, English Haven, that provides one-on-one ESL lessons to immigrants and refugees."*

—DANIEL



*"I'm currently planning a hackathon, a programming event that requires a lot of teamwork. I found that a lot of the skills I learned from LigerBots, like communicating goals, and developing an overview for a timeline have been directly translatable to pursuing this hackathon."*

—KEVIN



*"As a programming lead, I have learned to think about and approach problems in real life with much more careful logic and problem-solving skills."*

—JACK



*"I've used the CAD I learned at LigerBots to design and build soccer-playing robots with my own 3D printer."*

—LINDA



**TERADYNE**



EDUCATE • INNOVATE • INSPIRE



**Cao Family**  
**Chaudhury Karim Family**  
**Franklin Family**  
**Housman Family**  
**King Family**  
**Nedeljkovic Family**

**Preston Family**  
**Saitz Family**  
**Sangiolo Family**  
**Schwartz Family**  
**Wang Ji Family**