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WORLD TOUR 2024

Thaddeus and the LigerBots

A Guide to the LigerBots, 2023

FIRST Robotics Team 2877

NEWTON NORTH AND SOUTH HIGH SCHOOLS

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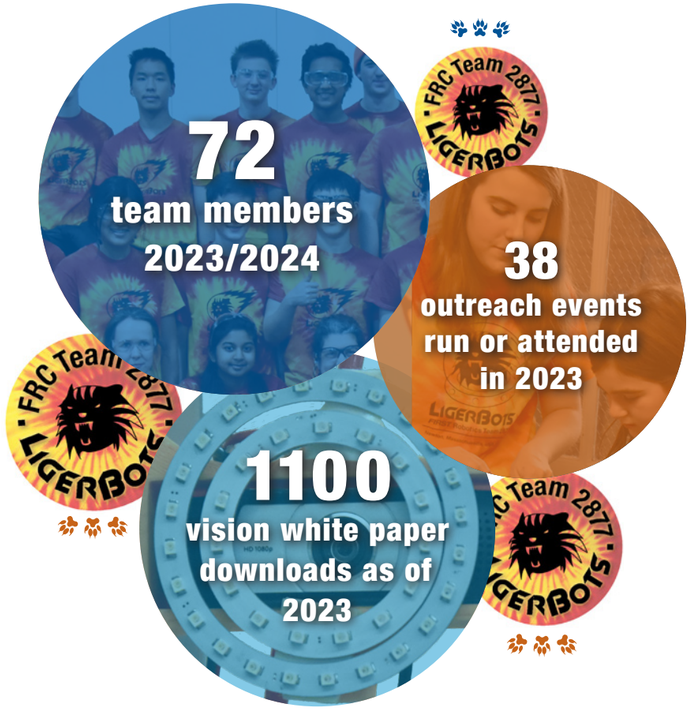


LigerBots at the New England FIRST District Championship, April 2023.

Contents

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 STEAM expo.

Row 1: STEAM advocacy—LigerBot delivers a TEDxBeaconStreet talk about FIRST as project based learning; STEAM training—electrical mentor and CTO solder an electrical test bench. Row 2: sponsor relations—LigerBots visit sponsor Fowler High Precision; STEAM 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. A recent graphics director joined the team with a background in digital illustration 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 technical training each year by breaking first-years into groups; then, using previous FIRST games as a guide, students start learning the engineering process by creating game strategies and robot designs. Each group 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 also helps team members understand 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 engineering projects regularly help with team fundraising, photography, and blog posts.

Our training projects have resulted in five white papers on Chief Delphi, a web forum serving the FIRST community. Our papers on robot vision, on the measurement of display latency, on making an electrical test bench, on the design and construction of a "clean-up-bot," and on distance learning and teaching have received thousands of views and downloads. We share our robot code on the online software development platform GitHub, maintain a robot build blog as part of the Open Alliance on Chief Delphi, and publish our CAD on browser-based CAD program Onshape.

A new LigerBot learns to disassemble a motor.

Row 1: LigerBot jeweling 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 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 Mk4i 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" while 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 equipment bags and robot bumpers in build season

LigerBots Manage Our Projects

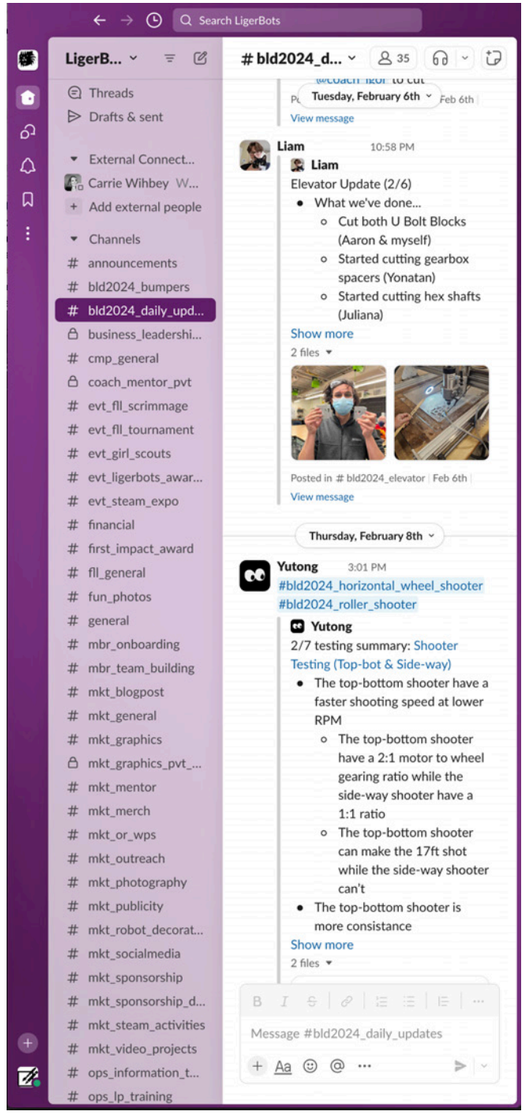
LigerBots work used to stop at the end of each team meeting, when easy communication and access to resources ended, but now we can do many LigerBots projects, such as CAD and sponsor newsletters, whenever we want to. That's because during the pandemic we had to fully switch from daily stand-up meetings and use of project management boards with task stickers to an integrated and electronic system that was available 24/7. We had started down this electronic path in about 2016, but the Covid-19 pandemic moved the system forward rapidly, and now we can't imagine being without it.

We instantly communicate via messaging app Slack, meet on Zoom at our convenience, create collaborative documents on Google Docs, Sheets, and Slides, store our documents on a team Google Drive, and store our images on photo-sharing website Flickr. A second, publicly accessible Google Drive allows us to share documents with the greater community.

We create a Slack channel for every project we undertake, and pin links to Drive documents and to Flickr images on Slack channels, so we can find them easily. During the robot build season our group leaders post their groups' progress in a "Daily Updates" Slack channel in addition to meeting in person twice a week. This system helps keep the entire team informed about our work on the robot, and moves our build forward more quickly

LigerBots leave our in-person meetings excited to continue working on our projects—sometimes multiple Zoom breakout rooms are filled with LigerBots collaborating on CAD, software, spreadsheets, text documents and slide decks.

Our team members report they have learned to transfer their new sophistication in project management to their academic work and other extracurricular activities.



A sample of messages on the LigerBots "daily updates" Slack channel. At the left side of the image are some of the dozens of project-specific channels subscribed to by one LigerBots team member.

We Build a New 120-Pound Robot Every Year

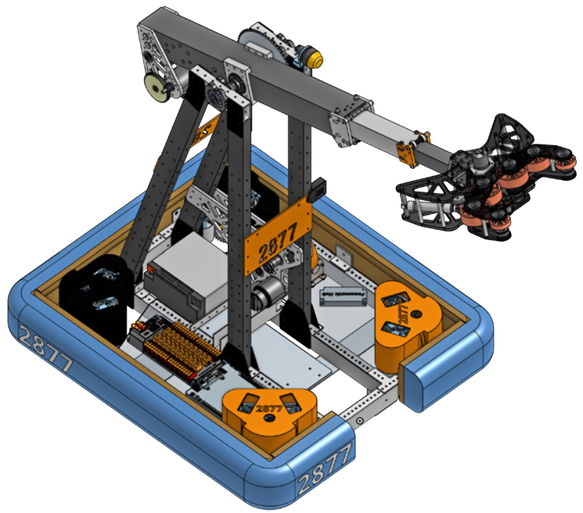
All of the LigerBots fall training in engineering and marketing skills is put to use during the most exciting and demanding part of our year, the winter, robot-build season.

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. The leaders of our design and constructions groups post daily on Slack and meet in-person twice a week to coordinate their work and update each other on their groups' progress.

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 resources to spend on improving our competition robot. Once the robot is mostly finished we take it to the practice area where our mock field elements are set up, to test the performance of the robot's mechanisms and refine our driving software and vision system.

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 events also continue.

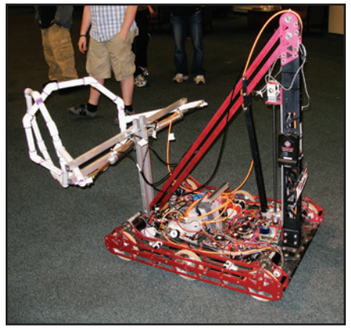
Our awards group prepares a written submission and an oral presentation to compete for the FIRST Impact Award, which goes to the team at each competition that best exemplifies the principles of the FIRST Robotics Competition program.



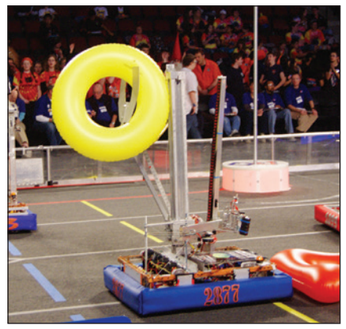
LigerBots 2023 robot, "Atlas"

This page: the LigerBots 2024 robot. Opposite page, row 1: using computer aided design (CAD) to draft the robot; snapping out polycarbonate pieces cut on the team's computer numerically controlled (CNC) router; prototyping the "crab claw" game piece intake. Row 2: cutting chassis pieces with an angle grinder; calibrating a mill to cut a piece of aluminum box tube. Row 3: assembling the intake arm extension gearbox; assembling and wiring the arm support structure; mounting the arm onto the support structure. Row 4: meeting of build group leaders; assembling sewn bumper covers; the finished robot being hauled to the practice area.

Fifteen Years of LigerBots Robots

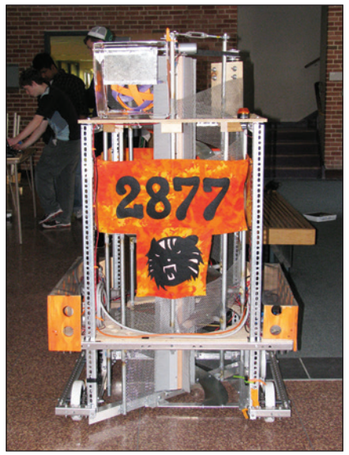


2008, Overdrive

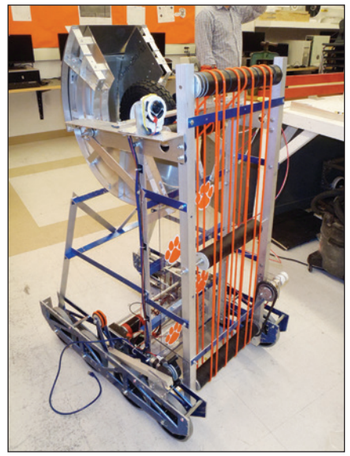


2011, Logo Motion

2014, Aerial Assist



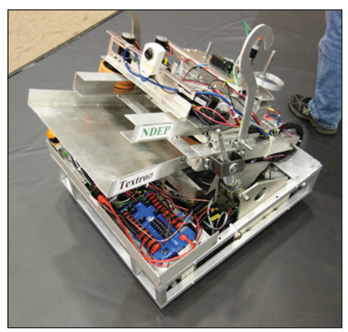
2009, Lunacy



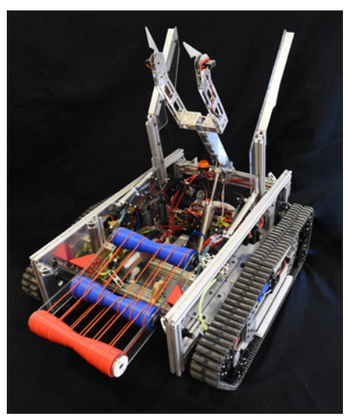
2012, Rebound Rumble

2015, Recycle Rush

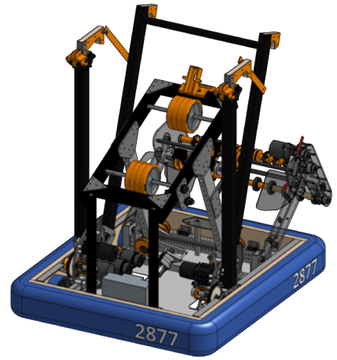
2010, Breakaway



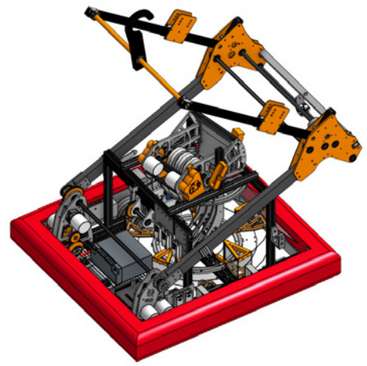
2013, Ultimate Ascent



2016, Stronghold
"Talos"

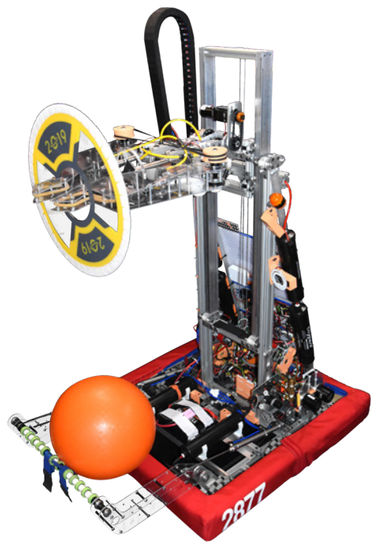


2022, Rapid React
"Prometheus"

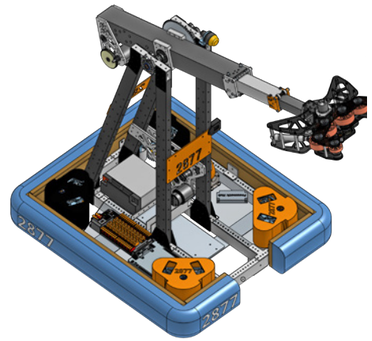


2020, Infinite Recharge
2021, Infinite Recharge at Home
"Perses"

2017, Steamworks
"Daedalus"



2019, Destination: Deep Space
"Thanos"



2023, Charged Up
"Atlas"

2018, Power Up
"Chronos"

LigerBots Robot Design Process

PRESEASON TRAINING AND IMPROVEMENTS

Hands-on Projects

- In the fall, LigerBots run hands-on training sessions in many of our 20 team skill areas, including 10 in technical areas. There is special emphasis on CAD, manufacturing, programming, and electrical design. Examples from 2024 include:
  - CADing and beginning construction on an outreach robot.
  - Brainstorming and prototyping mechanisms for a previous FRC game.
  - Designing and prototyping mechanisms to handle an array of game pieces.
  - Teaching the basics of programming, using Arduinos and sensors.
  - Teaching robot programming in Java and testing it on robots from previous years.

Game Analysis

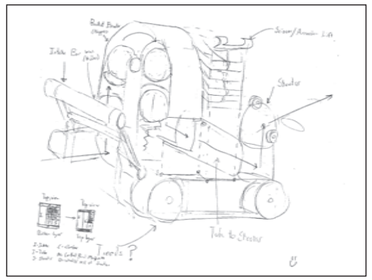
- Veteran LigerBots choose videos of matches from the previous several seasons of robot games. New team members are invited to watch these videos in a group and think about robot design and game strategy before the new build season.
- We run a mock Three-Day Design, in which we split into groups to strategize and design a robot in three days.

Improvements to Manufacturing Processes

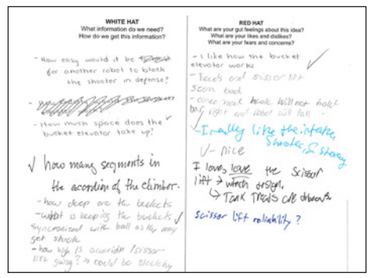
- Creating an internal bill of materials (BOM) for sub-projects, to improve project management.
- Training students on the lathe to expand manufacturing capabilities.
- Implementing a CNC and mill queue to ensure mechanisms have equal machine time.
- Preparing students to mill metal with projects using 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.

LigerBots coach teaches a first-year to solder.

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



Sketch of a potential robot design.



Critiques of above sketch.

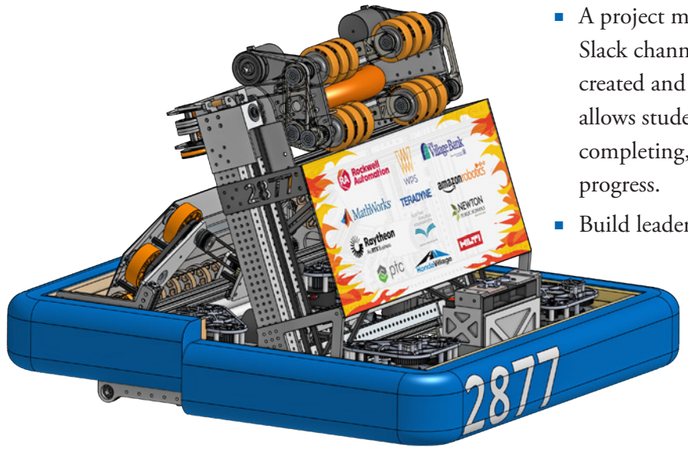
ITERATIVE ROBOT DESIGN

Three-Day Design

- ***Day 1:*** We watch the game kickoff as a team, and then meet in small groups to analyze the game and discuss strategy. At the end of their deliberations, groups post their strategies on Slack, and student leaders choose the best strategy. 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.
- ***Days 2:*** The entire team continues in our small groups to brainstorm mechanisms that best implement our chosen strategy.
- ***Day 3:*** Groups present their proposed robot designs to the whole team, and the team discusses them.
- ***Day 5:***
  The team splits into build groups to start CADing the robot in Onshape and prototyping the mechanisms. Prototypes are built of materials as identical as possible to materials used in the final mechanisms, allowing more realistic test results. A CAD model of the entire robot is completed as quickly and thoroughly as possible.
- ***Continuing into build season:*** LigerBots continue to test, redesign, and prototype mechanisms. As final decisions are made about mechanisms, wiring is run, code is written, and bumpers are made. Mock field elements are constructed to allow for robot testing. As we test the robot, we fine-tune our mechanisms, driving code and vision system.

Design Decisions, Prototyping and Continuous Improvement

- ***Day 4:*** Build leaders now combine ideas from the various groups to create as many as three designs for each mechanism.



LigerBots 2024 robot CAD, in progress.

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 Slack channels for each build group and documents created and shared on the team Google Drive, allows students to identify and staff tasks that need completing, collaborate on solutions, and track progress.
- Build leaders post every day in the Slack "Daily Updates" channel and meet twice weekly in person to ensure that the team is working toward its goals.

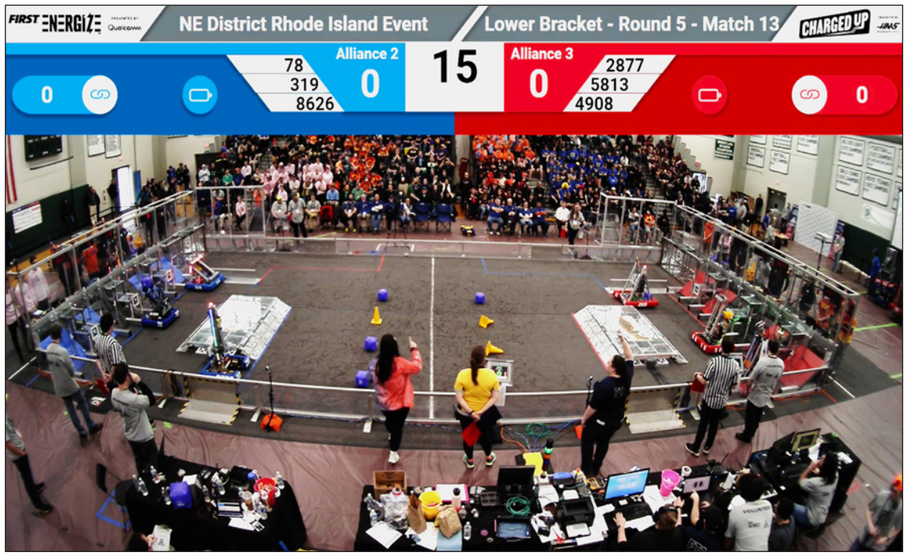
LigerBots Compete

FIRST Robotics competitions are the big payoff for all of the LigerBots training and our work during build season. 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 Houston. The LigerBots made it to the World Championship four times in our first ten years.

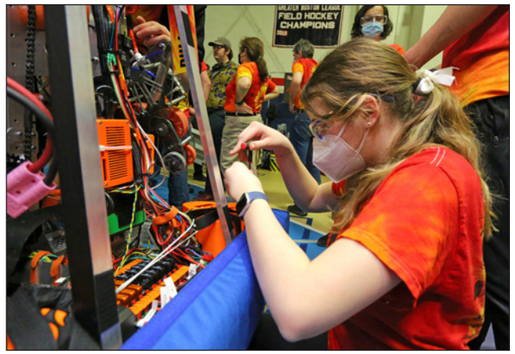
FIRST Robotics qualifying matches are played by two randomly selected alliances of three teams each, on a playing field about the size of a basketball court. We have a different alliance for each qualifying match. Our alliance drive teams guide our robots around the field to earn points cooperatively 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, our team's organization, and our 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 38 awards during our first 15 years.



This page: the arena at the 2023 New England District Rhode Island Event, in North Scituate, RI. Opposite page clockwise from upper left: LigerBot repairs the robot in the pit; LigerBots drive team guides the robot during a match; LigerBots talk to awards judges; 2023 robot on the playing field; LigerBots cheer in the stands; LigerBots receive an award; 2023 pit crew in the robot repair pit.



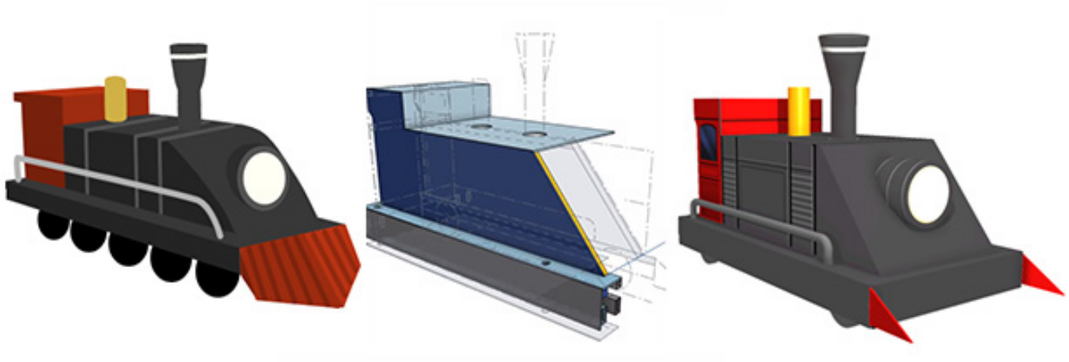
LigerBots Design an Award-Winning Game

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.

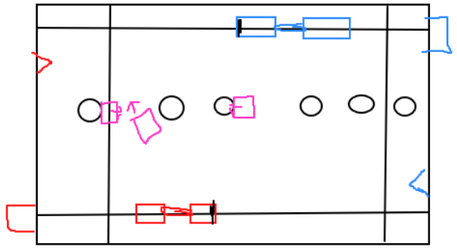
The Game Design Challenge presented a unique opportunity for various LigerBots skill groups to collaborate closely in order to execute a shared vision. Each group offered valuable knowledge and diverse perspectives to the development of the game. Our strategy group worked with our engineers to detail 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 management to streamline the partnership between the groups.

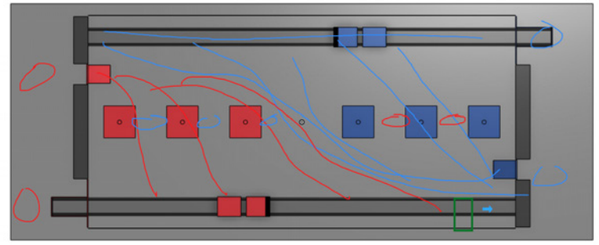
The LigerBots developed a concept involving trains owned by two rival construction companies that were competing to complete new telegraph systems for two nineteenth-century towns. We called the game "Locomotive Linkage." Each robot alliance (of three teams) represented one of the construction companies. 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.

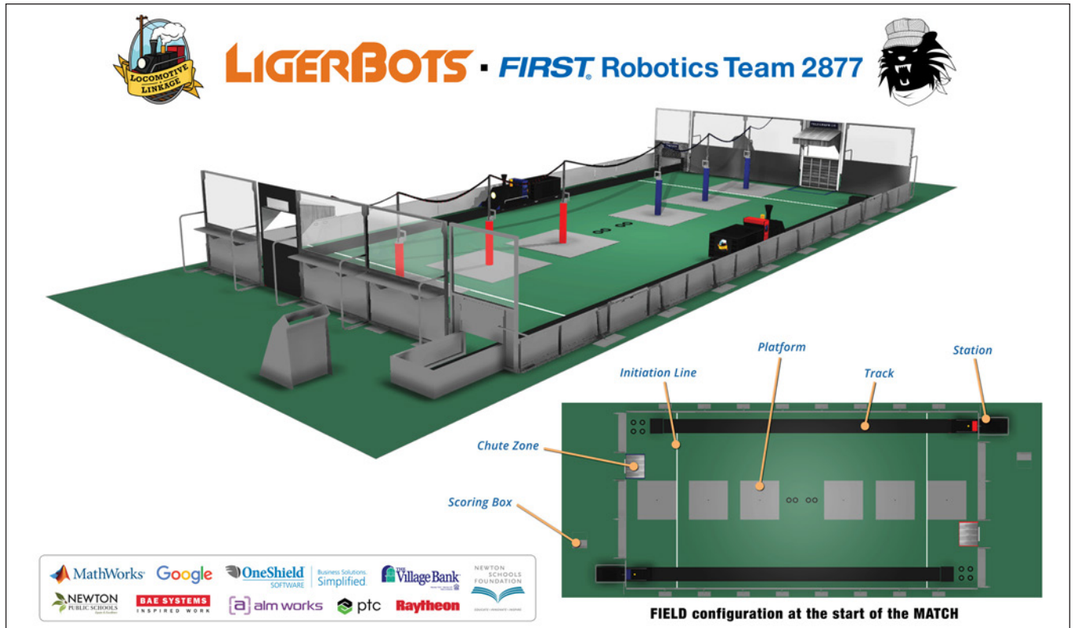
We were thrilled to learn a few weeks after we completed the challenge that we had won the Engineering Design Award from FIRST at the district level! The hours spent together on Zoom strengthening our final game design also strengthened our team spirit. Since the 2021 season we have remembered our pride 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.

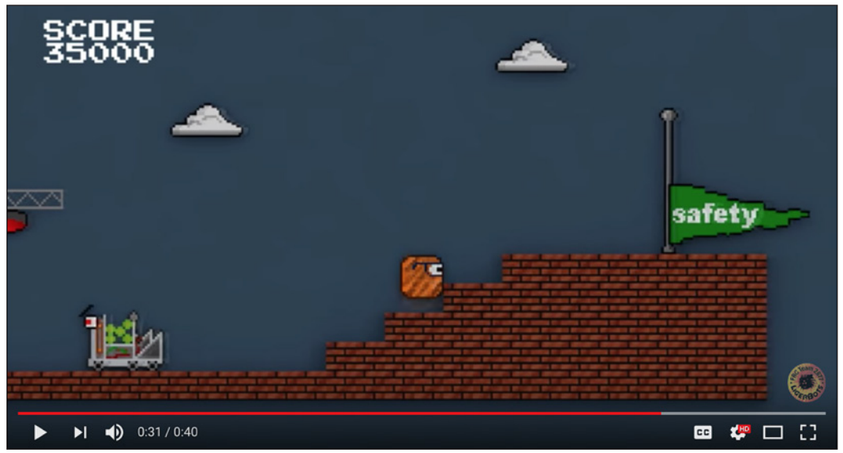
AUTONOMOUS PERIOD: During the 15-second AUTONOMOUS PERIOD, ROBOTS follow pre-programmed instructions. ALLIANCES score points by:

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 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.

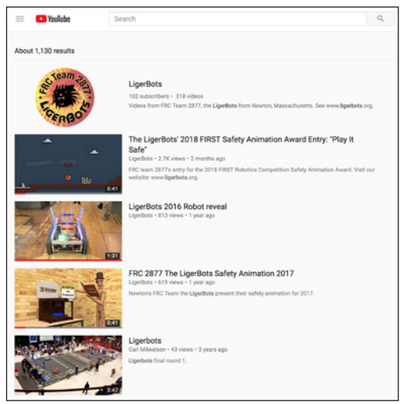
Rising to the Animation Challenge

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 Robotics Awards

Year	Event	Award
2023	New England Championship	Dean's List Finalist Imagery
	North Shore District	Sustainability
	Greater Boston District	Competition Finalist
2022	New England Championship	Engineering Inspiration
	North Shore District	Gracious Professionalism
2021	FRC Game Design Challenge	Engineering Design
	Scandium Group	
2020	Greater Boston District	Chairman's
	N. Connecticut District	Imagery
2019	New England Championship	Dean's List Finalist
	Central Mass District	Entrepreneurship
2018	Worldwide competition	Safety Animation
	Greater Boston District	Engineering Inspiration
	North Shore District	Imagery
	Greater Boston District	Competition Finalist
2017	Rhode Island District	Entrepreneurship
	WPI District	Gracious Professionalism
2016	New England Championship	Innovation in Control
	WPI District	Entrepreneurship
	Boston District	Innovation in Control
2015	New England Championship	Chairman's
	Northeastern District	Competition Finalist
	UMass Dartmouth District	Chairman's
2014	Northeastern District	Competition Finalist Spirit
	WPI District	Competition Winner Creativity
2013	Boston Regional	Creativity
2012	Boston Regional	Gracious Professionalism
	WPI Regional	Gracious Professionalism
2011	WPI Regional	Website Dean's List Finalist
2010	Boston Regional	Team Spirit
	WPI Regional	Imagery
2009	Hartford Regional	Rookie Inspiration Highest Rookie Seed
	Boston Regional	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 STEAM 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 17 activities available, and three in development.

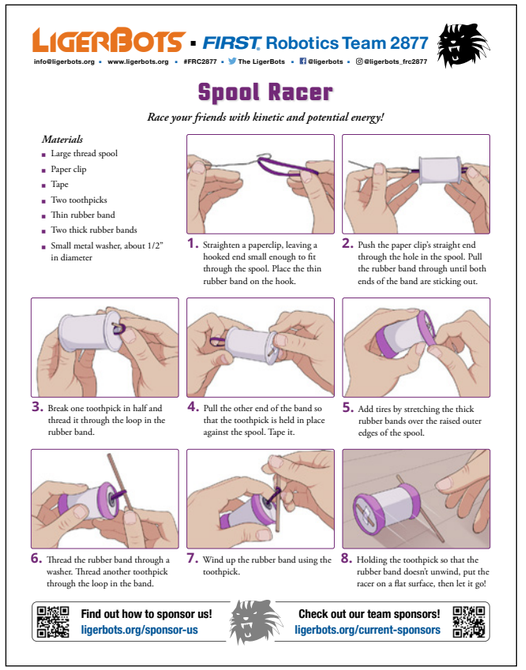
Our activities and flyers have helped us organize our STEAM outreach, and also have been a key part of our FIRST LEGO League involvement. We host an annual "FLL Info Night" to encourage the creation of new FLL teams in our area. During the info night we set up STEAM activities for students while parents listen to our presentation about FIRST. We also run a STEAM expo, usually at the LigerBots-hosted FLL MA East Championship, which includes LigerBots STEAM activities as well as hands-on demonstrations by local businesses. Since 2018 the Newton Girl Scouts have used this STEAM expo to replace their own event in which they earn a STEAM 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.

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

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



LIGERBOTS • FIRST Robotics Team 2877

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Spool Racer

Race your friends with kinetic and potential energy!

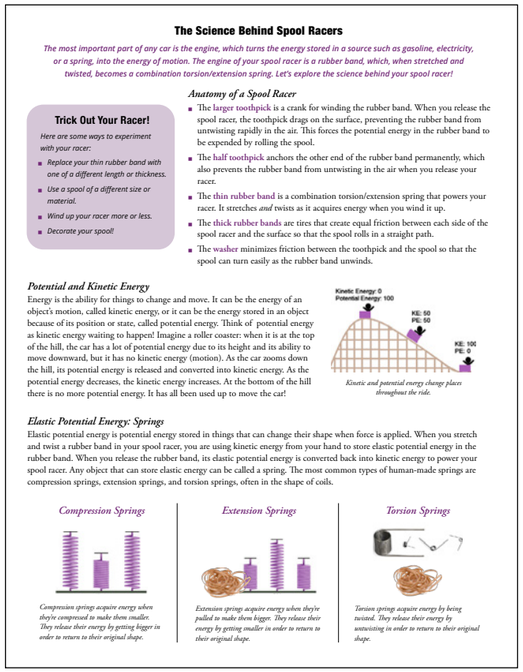
Materials

- 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!

Find out how to sponsor us! ligerbots.org/sponsor-us

Check out our team sponsors! ligerbots.org/current-sponsors



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 unwinding 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 unwinding 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 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.

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*
- *popsicle 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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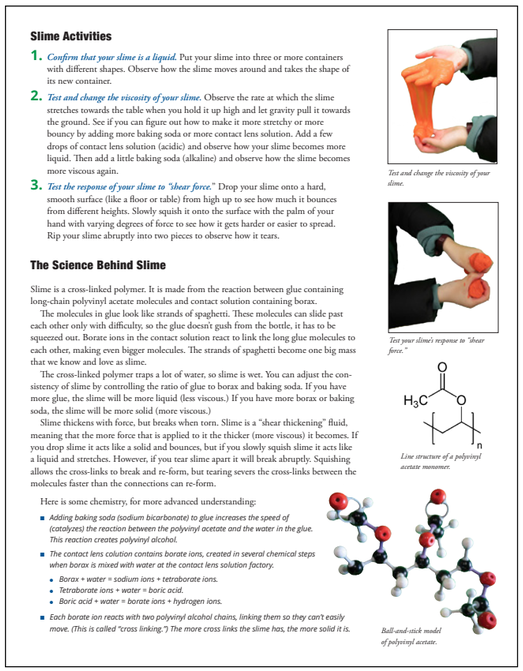
Check out our team sponsors! ligerbots.org/current-sponsors

Slime flyer.



Slime Activities

1. ***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.
2. ***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.
3. ***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.

Test and change the viscosity of your slime.

Test your slime's response to "shear force."

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.

Line structure of a polyvinyl acetate monomer.

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.*

Ball-and-stick model of polyvinyl acetate.

LigerBots Promote FIRST LEGO League

Since 2015, LigerBots have organized, coordinated, and staffed FLL competitions every year, often with an accompanying, hands-on STEAM expo and robot zoo. We invite local companies, high school clubs, and other FIRST teams to bring activities for children and we invite the public in to watch the tournament, enjoy the activities, and drive the robots.

Feedback about our tournaments from FLL coaches, parents, students, and volunteers has been so positive that New England FIRST has asked us to host the FLL Massachusetts East Championship six times, including in 2023. This year, 14 teams competed at the LigerBots-hosted Newton Qualifier, and 48 FLL teams took part in the Massachusetts East FLL Championship.

"Teddy & Grace got a huge thrill from playing with robots at the annual LigerBots STEAM Expo at Newton North High School. And I got a kick out of speaking with student engineers from across the district. . . ."

—Jake Auchincloss
U.S. Representative, MA Fourth District

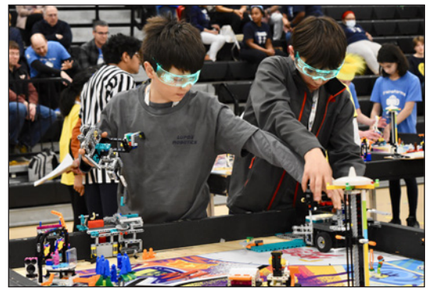
In 2023 we also hosted our first FLL scrimmage for local teams that wanted to participate in simulated matches before their real-world competitions. LigerBots educational partner the WPS Institute invited us to use their Community Learning Lab in Newton Centre, and eight teams came to test out their FLL robots while LigerBots team members acted as referees for matches and judges for projects.

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. We create an extensive album of each FLL event on the photo site Flickr and share it with participating teams, to remind them and us what a great time we all had. We usually get over a thousand views of our MA E. Championship album.

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 for kids while the parents listen to an overview presentation about FIRST. LigerBots have mentored several FLL teams that were created at our recent FLL info nights. Team members taught younger students the basics of programming, robot design, essay writing, and public speaking.

Visitors make crayons at the LigerBots FLL Info Night.

LigerBots and FLL team members at an FLL scrimmage at the WPS Community Learning Lab in Newton Centre.

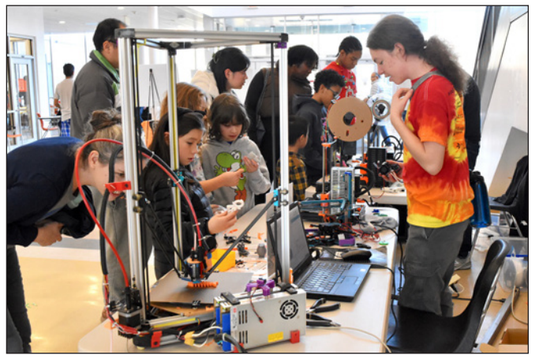


Clockwise from top left: LigerBots ref scores a match for the Electrified Chickens at the MA East FLL Championship; judges form a hand-slapping line during awards; parents snap a photo of their FLL teams in front of the LigerBots/FLL backdrop; everyone dances between matches and awards; teammates set up their robot before the start of a match.

LIGERBOTS STEAM EXPOS ARE ENGAGING





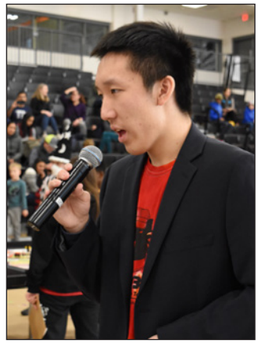



Row 1: Johnson String Instrument cello demo; FRC team Ultraviolet binary beads; LigerBots outreach robot with Newton City Councilor Tarik Lucas. Row 2: Star Wars 501st Legion (top), Newton Community Education articulated hand (bottom); LigerBots skeleton hand print; MGenius Academy electric cart. Row 3: NES Optica telescope; LigerBots 3D printing.

AT OUR FLL TOURNAMENTS, LIGERBOTS FILL MANY ROLES







Row 1: rolling out the protective mat in the gym at set up; refereeing. Row 2: selling food; resetting game table; emceeing. Row 3: making morning announcements; running audio/visual.

LigerBots Help Bring Girls into STEM Fields

We train LigerBots members to share their STEAM knowledge in a way that everyone can understand. Many of our FLL competitions include a STEAM expo (Science, Technology, Engineering, Art and Math) that brings in other FIRST teams and outside organizations to share their knowledge with the community.

We are especially interested in helping achieve gender balance in STEM fields. We do frequent outreach at local Girl Scout meetings. Since 2018, the Newton Girl Scouts have used our expo 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 2023/24, LigerBots have 25 girls out of 72 students on the team, and five of 16 active mentors are women. Two of our three CTOs in 2023/24 are girls. We have also normalized the idea of female build leaders. Four out of seven of our robot-build 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*
- *Circuit Lab*
- *Code Ninjas*
- *Einstein's Workshop*
- *Empow Studios*
- *Gamewright*
- *Green Newton*
- *Hatch Makerspace*
- *IRobot*
- *Johnson String Instrument*
- *Massachusetts National Guard*
- *MassBay Community College STEM*
- *MGenius Academy*
- *Microsoft*
- *New Art Center*
- *New England Model Engineering Society*
- *New England Section, Optical Society of America*
- *New England R2 Builders*
- *Newton Free Library*
- *Newton Community Education*
- *Newton South Women In STEM*
- *NuVu*
- *Orimagi.io*
- *Prospect Hill Forge*
- *Rise Robotics*
- *Russian School of Mathematics*
- *SharkNinja*
- *Society of Women Engineers*
- *Star Wars 501st Legion*

Clockwise from top left: binary beads at FLL Info Night; balloon cars at MA East FLL Championship STEAM expo; robot at Newton's Earth Day festival at City Hall; LigerBots mentor teaches female team members; LigerBot reads to girls at a Daisy Scout meeting.

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 science, technology, engineering, art, and math (STEAM) ideas with our community. Students learn to communicate the messages of FIRST by practicing giving short 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 origami, slime, binary beads, balloon powered cars, skeleton hand prints, and solar ovens, among others. All of our STEAM activity instructional flyers, created by our student graphics group, are available on the team website for the public to download and use.

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 2023, we came back strong, attending or running 38 events that year. These ranged from bigger community events like the Boston GreenFest to smaller gatherings like our visit to Boy Scout troops with our robot. All of our team members are expected to take part in several of these outreach events each year, to help young people in our community learn about the joy of STEAM and opportunities in FIRST.

Newton Memorial Day parade.

Clockwise from top left: Newton Green Expo; Newtonville Village Day; Watertown Faire; Saint John School of Wellesley; Newton Pumpkin Smash; Carroll Center for the Blind.

LigerBots Do Outreach Everywhere!

Events with LigerBots sponsors

- *Rockwell Automation Fair*
- *PTC LiveWorx, visit to PTC headquarters*
- *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*
- *MA East FLL Championship + STEAM expo*
- *Mentoring FRC 6740, Glue Gun & Glitter*
- *Field trip to the Museum of Printing*
- *Field trip to the Museum of Science and Industry*

School events

- *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 & Cabot Elementary School science days*
- *Cabot Elementary School Invention Invasion*
- *Weston Field School robot demo*
- *St. John School visit*
- *Bowen Elementary and Newton South High School bike rodeos*

Government Relations

- *FIRST National Advocacy Conference*
- *Southern New England Advocacy Conference*
- *Mayoral candidate and city councilor 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*
- *Independence Walk, Carroll Center for the Blind*
- *Newton 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*
- *Healthy Kids Fair, West Suburban YMCA*
- *Demos at Cub Scout and Girl Scout meetings*
- *Girl Scouts STEAM patch workshop*
- *Boston Earth Day*
- *Boston Greenfest*
- *Cambridge Science Fair*
- *Newton Green-Expo*
- *MA Assoc. for Gifted Education (MAGE) conference*

Tech events

- *MA STEM Summit*
- *Boston STEM Fair*
- *Robotica*
- *Robo Madness*
- *RoboBoston*
- *From Global to Local MIT education conference*
- *MIT Blueprint high school hackathon*
- *MIT IDE Inclusive Innovation Awards*

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 OUTREACH FLYER (FRONT)

LIGERBOTS
FIRST® Robotics Team 2877
Newton North and South High Schools

140 Brandeis Road, Newton Centre, MA 02459
info@ligerbots.org ▪ www.ligerbots.org
#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 marketing training each fall, and have six to eight 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 2023 New England FIRST District Championship in West Springfield, MA

Find out how to sponsor us!
ligerbots.org/sponsor-us

Check out our team sponsors!
ligerbots.org/current-sponsors

LIGERBOTS OUTREACH FLYER (BACK)

LIGERBOTS
FIRST® Robotics Team 2877
Newton North and South High Schools

140 Brandeis Road, Newton Centre, MA 02459
info@ligerbots.org ▪ www.ligerbots.org
#FRC2877 ▪ The LigerBots
@ligerbots ▪ @ligerbots_frc2877

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.

LigerBot and mentor work on mock playing field elements

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.

FIRST Opportunities for Younger Students

- FIRST LEGO League (FLL) Challenge is robotics for students in grades 4 – 8. Email: fll@ligerbots.org
- FIRST LEGO League Explore is for students in grades 1 – 3.
- FIRST LEGO League Discover is for students in pre-K –1

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

LigerBots pit crew in our repair pit, with Atlas, our 2023 robot

The Engineering and Business Skills We Learn

- Mechanical engineering
- Electrical engineering
- Programming
- Computer Aided Design
- Gracious Professionalism
- Entrepreneurship
- Finance
- Project planning
- Leadership
- Teamwork
- Mentorship
- Public speaking
- Graphic design
- Writing
- 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 Invent Assistive Devices at NEU

In the summer of 2023 nine LigerBots invented low-cost devices to improve the lives of nursing teachers and those of disabled journalists through two pioneering internships at Northeastern University's (NEU) Enabling Engineering (EE) program. New England FIRST executive director Michael Fantom, who was connected with the EE program, knew about the high level of engineering, project management, and communication skills LigerBots team members have acquired, and decided to act as a matchmaker between EE and the LigerBots.

Real-world clients submitted requests for devices to the EE summer groups. Two nurses from Brigham and Women's Hospital asked for a teaching model that would help nurses identify and treat a hematoma (an internal bruise) located on the thigh. A filmmaker in Malawi associated with the Disability Justice Project requested a stable and flexible video-camera mount for her wheelchair.

"[I] had a meeting with the Roux Institute in Portland ME, a satellite of NEU—they love the internship concept of EE—and wish to explore how they introduce it at the Roux—[the LigerBots] are groundbreakers!!"

—Michael Fantom
Executive Director, New England FIRST

The hematoma group was challenged to make a model more accurate than the low-cost model that was already available, (which was just a stress ball over a golf ball,) but keep costs below $500. The model had to accurately simulate skin texture and the size and texture of a hematoma under the skin.

Using moldable silicone, food coloring, and sponges, LigerBots students were able to accurately simulate human skin. They added a water balloon to simulate the hematoma, with a pump to change its size. LigerBots programmed sensors that could detect when the pressure applied to the skin was the amount needed to stop the internal bleeding causing the hematoma. Green and red LED lights, for "right" and "wrong," were added to give feedback to nursing students. LigerBots created a website about the two EE internship projects, and sent frequent emails to their clients to keep them up to date on the projects' progress. YouTube presentation videos LigerBots created made their work available to everyone.

Aspiring engineer Yutong said that the hematoma model project was a great experience that used all of her LigerBots robot build-season engineering and project management skills. She said it felt like a real job, with a real client, and a real chance for her to lead a project.

According to *Northeastern Global News,* Deirdre Hamilton, a nurse at Brigham and Women's Hospital, told the LigerBots students, "You took our ideas and what you presented was what we hoped, what we imagined — in fact, it was even better than we hoped."

The biggest challenge for the camera-mount group was figuring out how to work remotely via video conferences with the client in Africa so that they understood her needs. They learned that the mount they invented needed to clamp onto different types of wheelchairs, withstand jostling from the chair moving over rough terrain, and be flexible without sacrificing stability. The group simulated rough terrain by putting down wood and other rocky materials under a wheelchair. They added a second clamp for use on the wheelchair leg to the single one for the footrest, to increase the shaft's stability, and added a handle for the user and a socket for the camera mount that rotated 360º for flexibility. They also made it easy to ship to the client by breaking it down into small pieces. The end product cost around $90, which kept it under the $100 target cost.

The LigerBots hope that other FIRST Robotics teams will have the same great experience they had at Northeastern's Enabling Engineering internship!

Clockwise from top: Three LigerBots members working on flexibility of the camera mount; two members adjusting the clamps on the mount; hematoma training model group members and two Brigham and Women's Hospital nurses with final model; two LigerBots members pouring a silicone mixture into the mold; final hematoma training model

LigerBots Run an "Anti-Hackathon"

During the Covid shutdown LigerBots CTO Kevin had a dream. He wanted to run a hackathon that went back to the good old ways, when hackathons were run in-person by amateur coders, for the benefit of other like-minded amateur coders using the software of their choice, not by the marketing department of big software corporations that ran hackathons online and gave prizes for use of their own products. So, in 2023 he and four LigerBots buddies organized "Beantown Bash," a free, in-person software "anti-hackathon" for high school and middle school students.

The organizers used their LigerBots skills to plan and run every aspect of the one-day event. They wrote corporate grant proposals and sent 300 cold sponsorship solicitation emails that garnered a total of $8000 from 16 corporate sponsors. Their powers of persuasion earned them a venue at the Joyce Cummings Center for computer science at Tufts University. They created enough publicity to attract 90 student hackers, plus funding and five software mentors from Hack Club, a global nonprofit network of high school makers & student-led coding clubs. And, they created a website on which to pull everything together.

On the day of the event student hackers created diverse projects, many with a bean theme, such as a first-person-shooter video game with characters that shot beans at cans, a bean-themed crossword game, and a dating simulator that matched a player's personality with an appropriate job internship. The organizers ran around with laptops and clipboards, making sure everything was running smoothly. The kids reported that they had a great time.

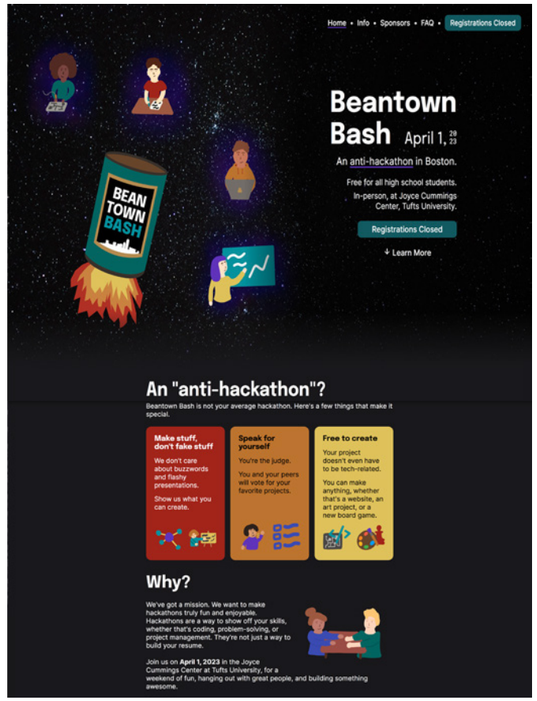
Beantown Bash was so successful that the organizers were inspired to take the event to the next level in 2024, and plan a software *and* hardware hackathon, called "Wonderland." Hardware hackathons require funds for a library of electronic and other device parts that students can use to make their own creations.

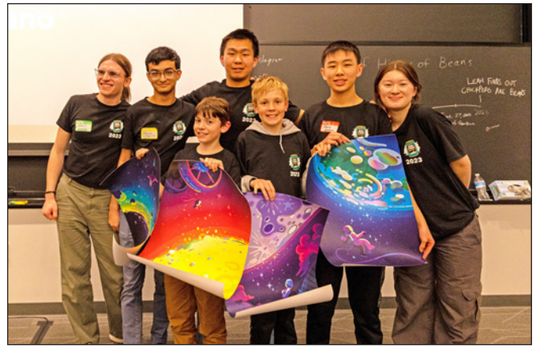
Even before the students could apply for a grant, Hack Club offered to run Wonderland as an official Hack Club event, and awarded the students a budget of $50,000.

As a result, the organizers will not have to scramble for sponsors, and Wonderland will be three days instead of one. Eighteen mentors from Hack Club will help students with a range of experience create their projects. Two-hundred-fifty students will travel from all over the world to join the event, with funding available to fly some of them in on scholarship from as far as Nigeria, India, and Ukraine. LigerBots educational partner the WPS Institute will open their Newton Centre Community Learning Lab to the hackathon and to students camping out overnight in their main building.

Wonderland organizer Roshan says that he was inspired to help create the Beantown Bash and Wonderland by the LigerBots experience of being physically present in a community of students who share the same interest and excitement about building things. In 2024 he and his fellow Wonderland organizers will be able to pay that love of building in a community forward to many other students from around the world.

The Wonderland website home page.





Clockwise from top left: BeantownBash.org home page; the queue at check-in; organizers Leah, Vivian, and Roshan confer; participants coding; project team presenting to other hackathon coders; the resistor value scanner team with their award posters; Beantown Bash group.

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 over-stimulation 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 "wonderful 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:

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:

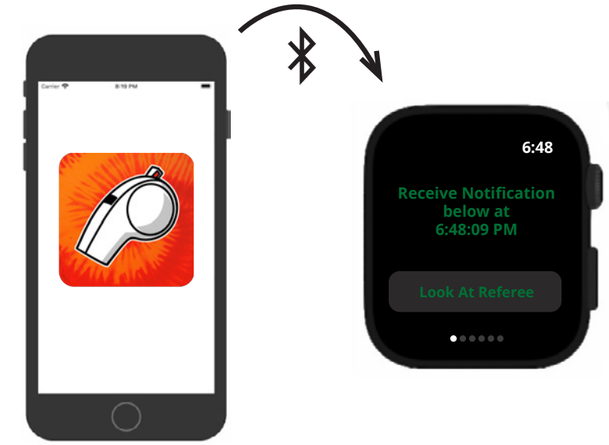
Our invention enables non-auditory communication between one or more officials, such as referees, coaches, or other people of authority recognized in a sport, and one or more deaf or hearing impaired players in a team sport or individual sport environment, utilizing a set of one or more transmitting 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 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.

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.

Section 2:

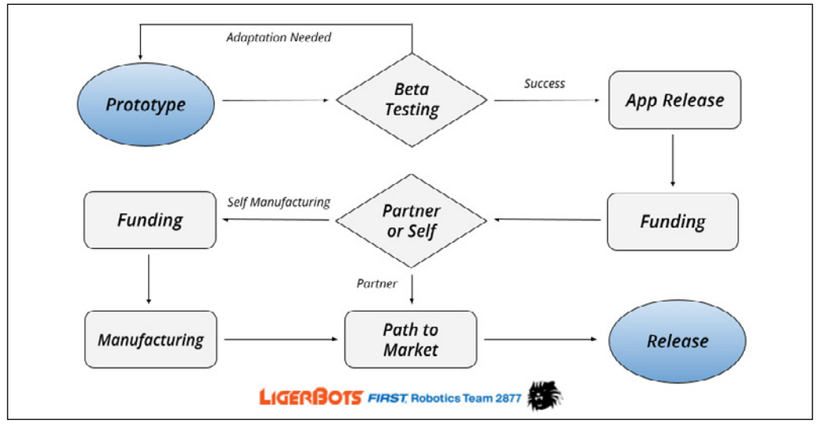
One embodiment of the invention, implemented as a two-agent system, comprises a first device or group of devices (henceforth listening device) each worn or carried by a person in

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 Connect with Our Government

We connect regularly with government officials to advocate for our team and for STEAM 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. We invite Massachusetts elected officials to our annual STEAM expos as visitors and as judges,

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.

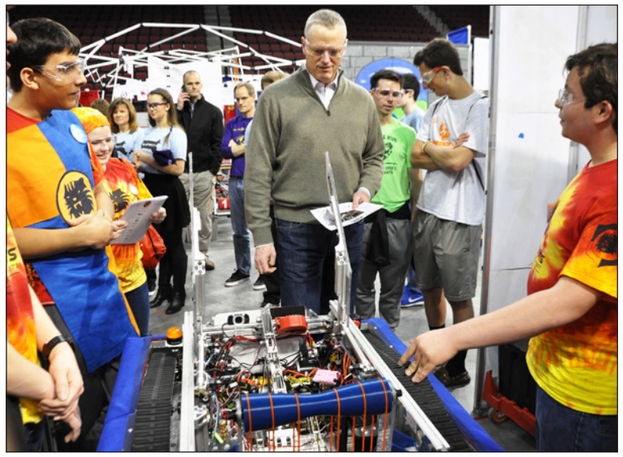
At the federal level, we played a crucial part in passing Act H.R.500, which directs the Department of the Treasury to mint and issue 350,000 $1 silver coins in commemoration of Space Shuttle Challenger astronaut Christa McAuliffe. In the summer of 2018 we worked with 25 teams at the FIRST National STEM 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 $250,000 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 STEAM 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.



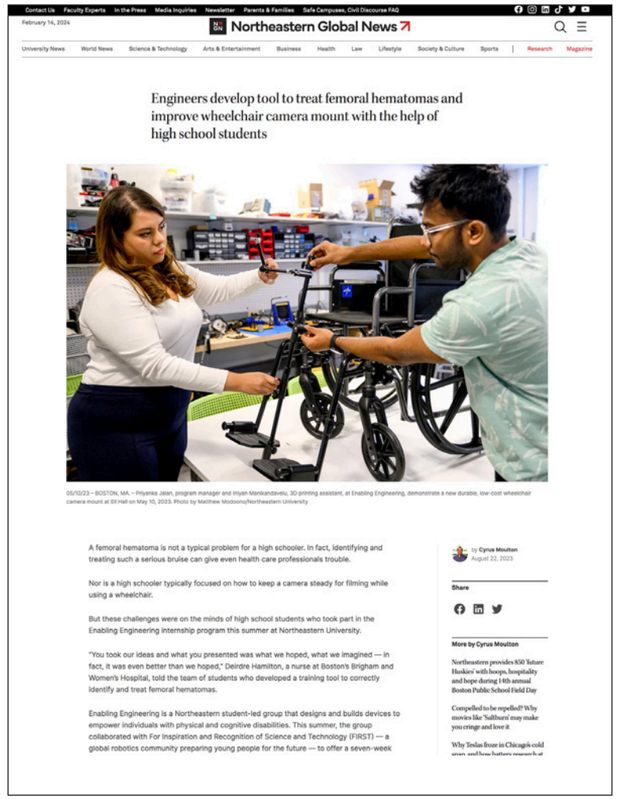
Clockwise from top: LigerBots students with MA representative Joe Kennedy, III at the 2018 National STEM Advocacy Conference in Washington, D.C.; Newton City councilors John Oliver and Martha Bixby visit the MA East FLL Championship in 2023; Newton mayor Ruthanne Fuller drives the LigerBots robot at the Just Think Expo; Massachusetts governor Charlie Baker gets an explanation the LigerBots pit during a Boston University FRC competition, 2016; U.S. Representative Jake Auchincloss' and son Teddy enjoying the LigerBots robot at the MA East FLL Championship, 2023.

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 in the *Newton TAB*. The NewtonSTEM.org newsletter, (now part of *Fig City News,*) has posted more than 113 articles about the team since 2011, with 31 more posted on *Fig City News.* 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 2,300 times.


Northeastern Global News

Engineers develop tool to treat femoral hematomas and improve wheelchair camera mount with the help of high school students

05/10/23 – BOSTON, MA. – Priyanka Jasan, program manager and Iniyan Manikandavelu, 3D printing assistant, at Enabling Engineering, demonstrate a new durable, low-cost wheelchair camera mount at 69 Hall on May 10, 2023. Photo by Matthew Modoono/Northeastern University

A femoral hematoma is not a typical problem for a high schooler. In fact, identifying and treating such a serious bruise can give even health care professionals trouble.

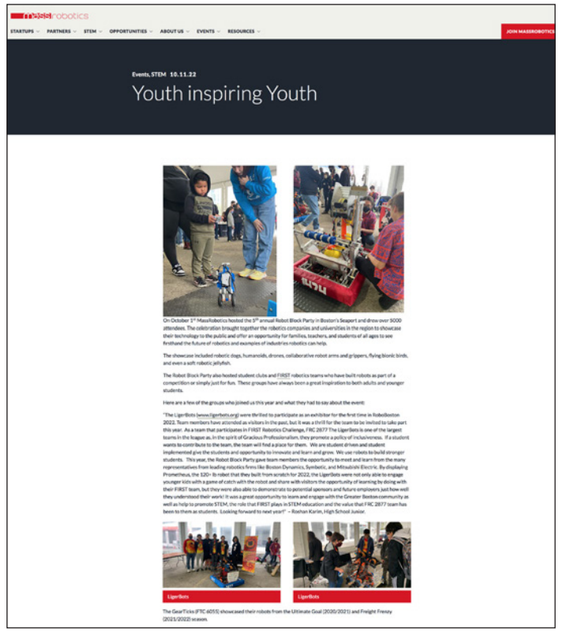
Nor is a high schooler typically focused on how to keep a camera steady for filming while using a wheelchair.

But these challenges were on the minds of high school students who took part in the Enabling Engineering internship program this summer at Northeastern University.

"You took our ideas and what you presented was what we hoped, what we imagined — in fact, it was even better than we hoped," Deirdre Hamilton, a nurse at Boston's Brigham and Women's Hospital, told the team of students who developed a training tool to correctly identify and treat femoral hematomas.

Enabling Engineering is a Northeastern student-led group that designs and builds devices to empower individuals with physical and cognitive disabilities. This summer, the group collaborated with For Inspiration and Recognition of Science and Technology (FIRST) — a global robotics community preparing young people for the future — to offer a seven-week

Article in Northeastern Global News *about LigerBots students' participation in the Northeastern University Enabling Engineering program.*


Youth inspiring Youth


Instagram

repauchincloss • Follow

repauchincloss Teddy & Grace got a huge thrill from playing with robots at the annual LigerBots STEAM Expo at Newton North High School. And I got a kick out of speaking with student engineers from across the district, including Newton, North Attleboro and Franklin.

When we got home, Teddy insisted that we build & program his own robot. His dad did his best but I'm not winning the Eastern Mass

97 likes
December 18, 2023

Log in to like or comment.

Fig City News

Community News Hub for Newton, Massachusetts

Tami Gambiza's Boston Marathon Run
Donate to support *Fig City News!*

LigerBots — Newton's high school robotics team — qualifies for New England District Championship!

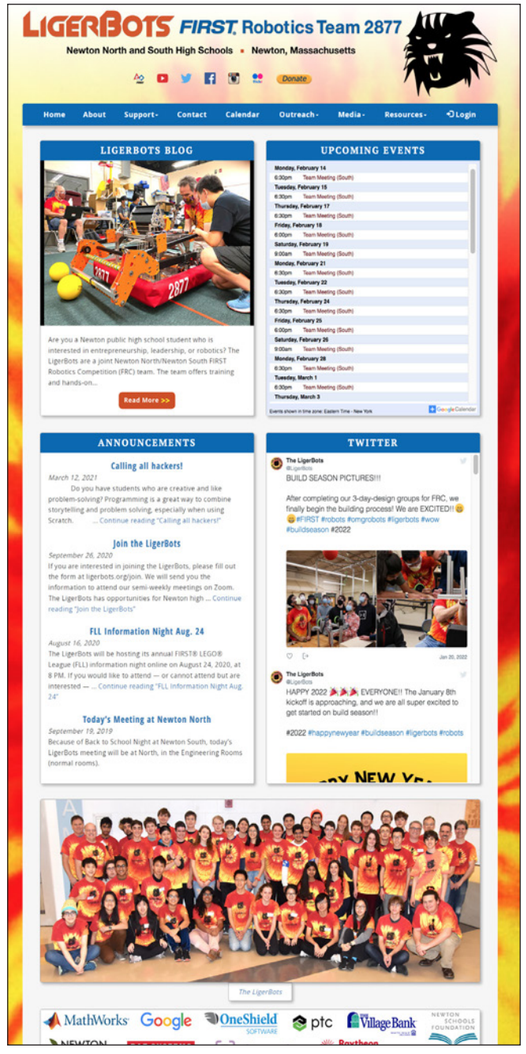
Trending News

Op-Eds & Letters

Contact

Clockwise from upper left: NewTV reporter interviews LigerBots at the JustThink Expo; story in Fig City News *about the LigerBots qualifying for the FIRST Robotics Competition New England District Championship; David Pogue of PBS series* NOVA *interviews LigerBots at the PTC LiveWorx conference; MA congressional rep Jake Auchincloss' Instagram post about the MA East FLL Championship; MassRobotics blog post about LigerBots attending RoboBoston.*

LigerBots Create Our Own Media



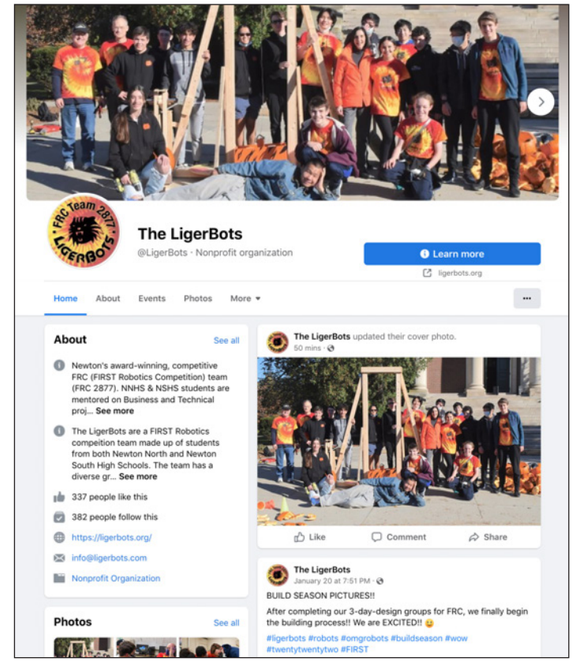
LigerBots website home page.

LigerBots Media

- *Website blog posts*
- *Media interviews*
- *TED Talks*
- *X (Twitter)*
- *Facebook*
- *Instagram*
- *Flickr photo album sharing*
- *YouTube videos*
- *Supporter updates*
- *Chief Delphi*
- *Printed marketing and outreach materials*

Part of a blog post.

LigerBots Instagram page.



LigerBots Facebook page.

LigerBots X feed.

LigerBots Connect with Our Sponsors

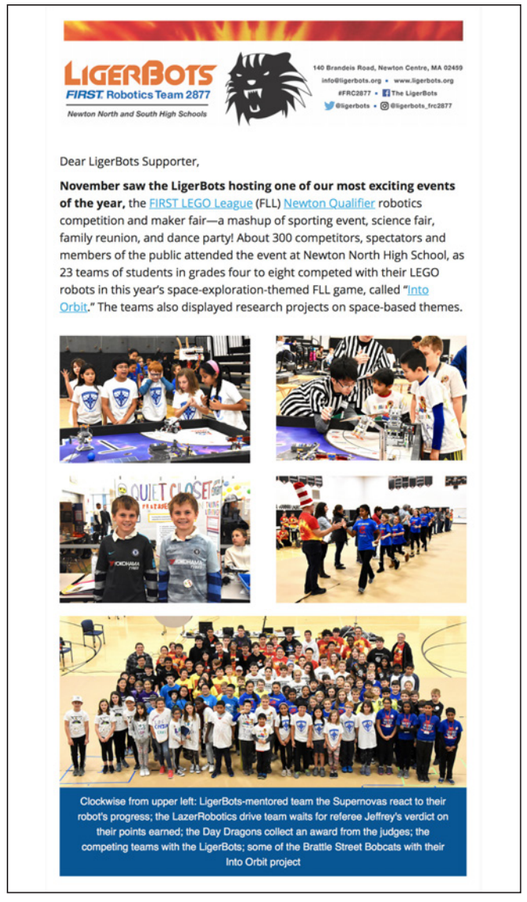
In order to sustain our robotics ventures, our extra projects, and outreach events, the LigerBots rely on support from our sponsors. We train students, both marketing-focused and technical-focused, on how to build and manage sponsor relationships. We run an annual training session in making a brief "elevator 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.



LIGERBOTS
FIRST Robotics Team 2877
Newton North and South High Schools

140 Brandeis Road, Newton Centre, MA 02459
info@ligerbots.org • www.ligerbots.org
#FRC2877 • The LigerBots
@ligerbots • @ligerbots_frc2877

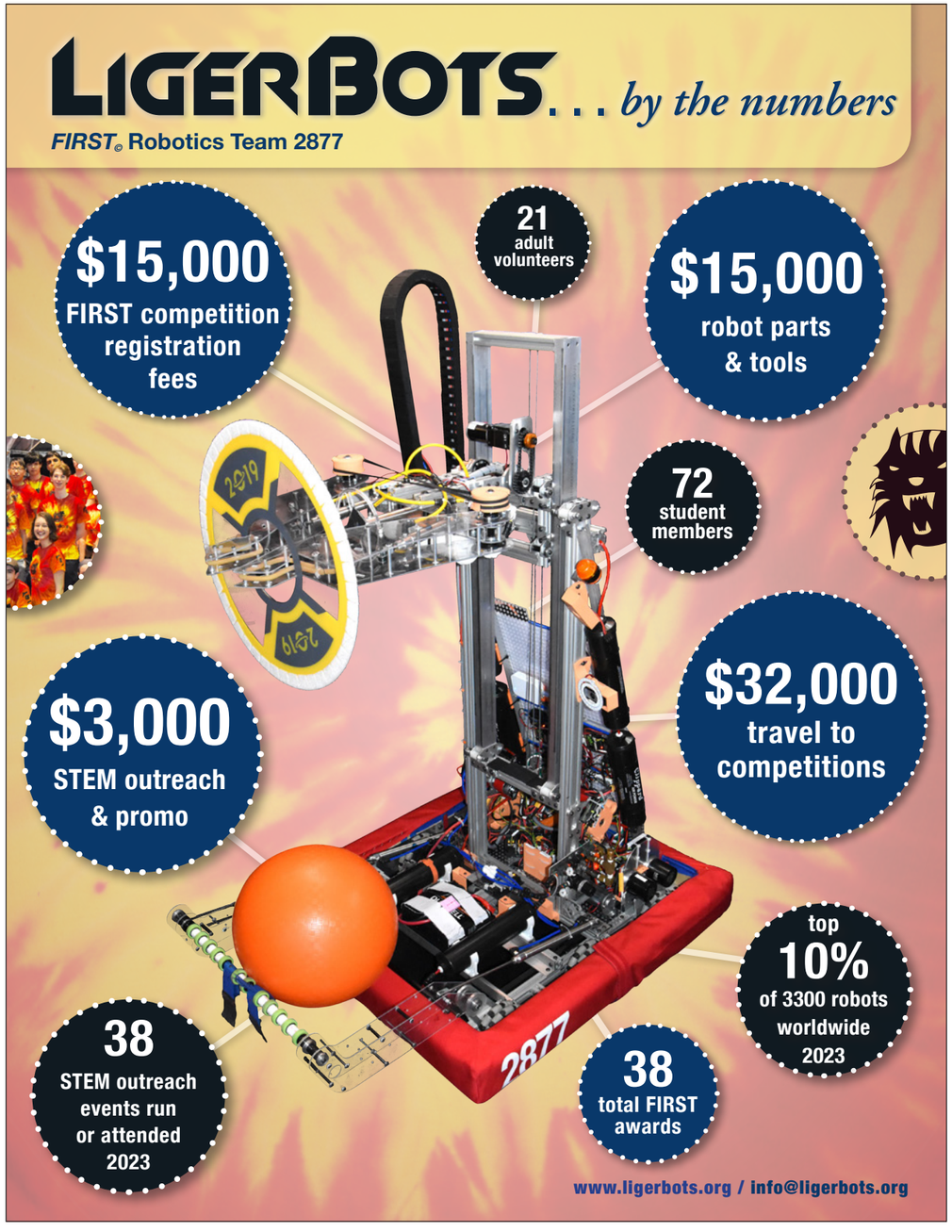
Dear LigerBots Supporter,

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 Championship.

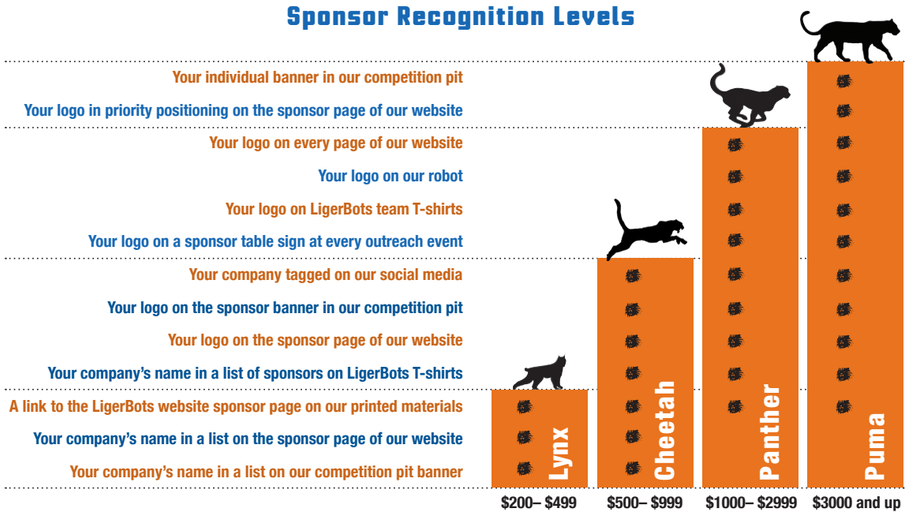
LIGERBOTS SPONSOR RECOGNITION LEVELS FLYER (FRONT)

LIGERBOTS
FIRST® Robotics Team 2877
Newton North and South High Schools

140 Brandeis Road, Newton Centre, MA 02459
info@ligerbots.org ▪ www.ligerbots.org
#FRC2877 ▪ The LigerBots
@ligerbots ▪ @ligerbots_frc2877

Support project-based learning that gives Newton students the skills they need to be contributors and leaders in STEM fields.

Sponsor Recognition Levels



Examples of Sponsor Logos on LigerBots Materials

Left to right: team outreach flyer, 2023 t-shirt back, 2023 competition pit, 2023 robot, website sponsor page

How to Sponsor the LigerBots

To sponsor, please email the LigerBots chief marketing officer at cmo@ligerbots.org

The LigerBots, Newton's award-winning high school FIRST Robotics team

LIGERBOTS SPONSOR RECOGNITION LEVELS FLYER (BACK)

The LigerBots are proud to recognize our sponsors at every event we attend. Thousands of people will see your brand and your support for STEM learning.

The Exposure You Will Get

Educational Events We Typically Attend

- Boston Greenfest
- Boston STEM Fair
- Needham STEM Week
- MIT Blueprint Hackathon
- Student Association for STEM Advocacy (SASA) Conference, in DC
- Southern New England STEM Advocacy Conference
- RoboBoston
- Newton Earth Day
- Newton Harvest Fest and Green Expo
- Cambridge Carnival and Robot Zoo
- Newton Mayor's STEM Night
- Newton Free Library Women in STEM Event
- "Newton Inspires" speaker night
- STEM promotion visits to Newton elementary schools and Cub Scout troops
- Club fairs and science open houses at Newton North and South high schools

LigerBots at the 2021 Boston Greenfest

FIRST Robotics Competitions We Typically Enter or Run

- FRC district competitions: attend two every year
- FRC New England Championship
- FRC World Championship in Detroit. 30,000 attendees. LigerBots attended 2009, 2014, 2015, and 2018.
- Newton Qualifier FLL Competition, plus maker fair: run by the LigerBots, 500 attendees.
- Eastern NE FLL Championship, plus maker fair: run by the LigerBots, 900 attendees.

Community Events We Typically Attend

- Newtonville Village Day
- Newton Highlands Village Day
- Newton Memorial Day parade
- Newton Harvest Fair
- Newton Pumpkin Smash
- Newton Green Expo

How to Sponsor the LigerBots

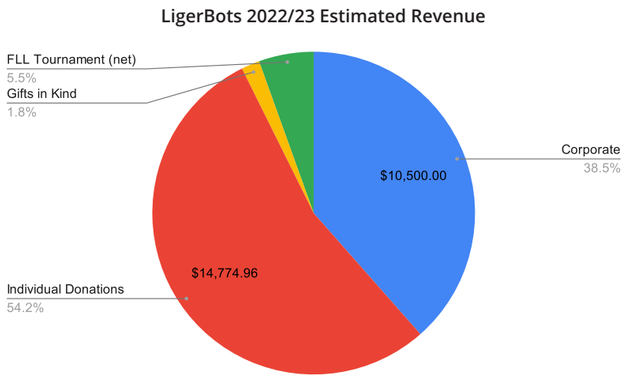
To sponsor, please email the LigerBots chief marketing officer at cmo@ligerbots.org

LigerBots at the 2023 Newton Memorial Day parade

LigerBots Fund Our Activities

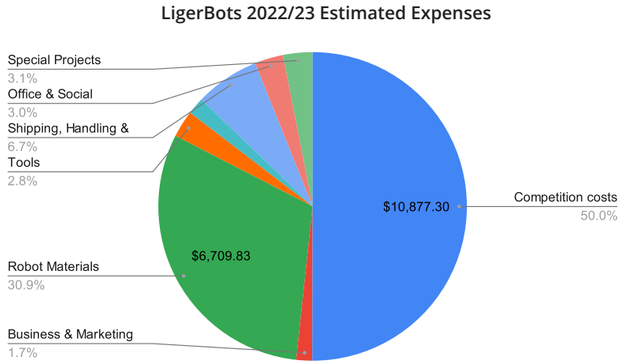
2022/23 Estimated Revenue

Corporate sponsorships	$10,500
Individual donations	14,775
In-kind donations	500
FLL tournament net income	1,500
Newton Public Schools	0
Total revenue	$27,275
Total expenses	$21,742
Net income	**$5,533**



2022/23 Estimated Expenses

Competition costs	$10,877
Business & marketing	364
Robot materials	6710
Tools	614
Field elements	390
Shipping, handling, tax	1,464
Office & social	651
Special projects	671
Total estimated expenses	**$21,741**



2022/23 Special Projects Details

IT & CNC parts	$671
Total special projects	**$671**

Purchasing Report — Purchase Date: 12/20/2018 — HOLDS — NOT TO EXCEED

Vendor Information: Name: McMaster-Carr; Address; Phone; Web Site

Requester Information: Name: Best Contact Information (for any questions); Team Member: Asa Zeren; Coach/Mentor: Igor Tempermie

Activity Codes: Robot Materials and Parts 1; Tools 2; Mechanism & Chassis Devt 3; Field Elements 4; Marketing and Business 5; FLL 6; Social 7; Office and Administration 8; Competition Expenses 9; Special Projects 10

Purchasing Report: LB19-0021; No. of Items: 15; Total Quantity: 57; Est'd Parts Cost: $408.89; Approval Date: 12/20/2018; Actual Parts Cost: $408.89; Total Cost: $443.63; Purchase Date: 12/20/2018; When complete please notify: Asa Zeren; Igor Tempermeister; xxx.xxx.xxxx

Item No.	Activity Code	Quantity Requested	Vendor Part Number	Vendor Part Description	Link	Quantity Purchased	Actual Cost
1	1 - Robot	20	93330A449	Female Threaded Round Standoff; Aluminum, 1/4" OD, 1" Long, 6-32 Thread Siz	https://www.mcmaster.com/93330A449	20	$10.00
2	1 - Robot	10	93330A483	Female Threaded Round Standoff; Aluminum, 1/4" OD, 2" Long, 8-32 Thread Siz	https://www.mcmaster.com/93330A483	10	$11.70
3	1 - Robot	2	2476K37	Roller 4" Diameter, 1-15/16" Width 35A (soft) Black	https://www.mcmaster.com/2476k37	2	$41.68
4	1 - Robot	1	6948K91	Battery Wire, Ultra Flexible, 6 Gauge, Black, 10ft	https://www.mcmaster.com/6948k91	1	$17.50
5	1 - Robot	1	6948K91	Battery Wire, Ultra Flexible, 6 Gauge, Red, 10ft	https://www.mcmaster.com/6948k91	1	$17.50
6	1 - Robot	1	88045K11	Mil. Spec. Hook, 1" Wide, Black, 15ft	https://www.mcmaster.com/88045k11	1	$7.05
7	1 - Robot	1	88045K12	Mil. Spec. Loop, 1" Wide, Black, 15ft	https://www.mcmaster.com/88045k12	1	$7.20
8	2 - Tool F	1	2933a42	1" drill bit, 1/2" shank, high speed steel	https://www.mcmaster.com/2933a42	1	$45.96
9	2 - Tool F	2	1413k44	Magic Tap Cutting Fluid for Aluminum, 16 oz	https://www.mcmaster.com/1413k44	2	$24.08
10	2 - Tool F	6	37095A35	Ball-End T-Handle Key, Cushion-Grip, 5/32" Size	https://www.mcmaster.com/37095a35	6	$21.24
11	2 - Tool F	5	2636A47	Long-Life General Purpose Tap Through-Hole Threading, 1/4"-20 Thread Size, with 4 Flutes	https://www.mcmaster.com/2636a47	5	$36.65
12	2 - Tool F	2	8949a839	TiN Coated High-Speed Steel Square-End End Mill 2 Flute, 5/8" Mill Diameter, 2-1/2" Long Cut, 4-5/8" Overall Length	https://www.mcmaster.com/8949a839	2	$70.64
13	2 - Tool F	2	2983A16	High-Speed Steel Square-End End Mill for Aluminum Uncoated, 2 Flute, 1/4" Mill Diameter, 3-1/16" Overall Length	https://www.mcmaster.com/2983a16	2	$43.58
14	2 - Tool F	2	8949A21	TiN Coated High-Speed Steel Square-End End Mill 2 Flute, 1/4" Mill Diameter, 2-5/16" Overall Length	https://www.mcmaster.com/8949a21	2	$31.24
15	2 - Tool F	1	2716A53	High-Speed Steel Square-End End Mill for Aluminum TiCN Coated, 3 Flute, 1/4" Mill Diameter, 5/8" Length of Cut	https://www.mcmaster.com/2716a53	1	$22.67
		57		Total Cost of Items		57	$408.89
				Discount			$24.66
				Sales Tax			$10.08
				Handling and Shipping			
				Total Cost			$443.63

Buyer's Notes

Overall: 15 Purchaser: Pam Wright; Vendor Order No.: 122DPWRIGHT; Date Purchased: 12/20/2018; Expected Delivery: 12/21/2018; Delivery Location: McVittie home; Date receipts uploaded: 1/20

Comments: Please upload all receipts to the 2019 Purchasing document folder on the google drive.

Shipment Details: Shipment 1: Carrier ground; Tracking No.: 1ZG10083039612693S; Shipment 2: Carrier; Tracking No.; Link(s) to receipt(s); Link(s) to receipt(s)

A LigerBots purchase order.

A Note About Our 2022/23 Finances

2022/23 corporate fundraising was low compared to pre-pandemic, but our individual donor fundraising campaign exceeded our expectations. Since many donations were received late in the year, most of the associated discretionary spending took place in fiscal year 2024.

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' robots.
- ***Clean-up bot***: Built an autonomous, all-terrain robot capable of cleaning up trash, snow, leaves, and animal waste, to keep our community cleaner.
- ***Swerve drive:*** Built a swerve drive train as student training project.
- ***Vision project:*** Assessed multiple cameras and processors to determine what would 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 purchasing system allows team members to specify items for purchase and approval and our head coaches 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

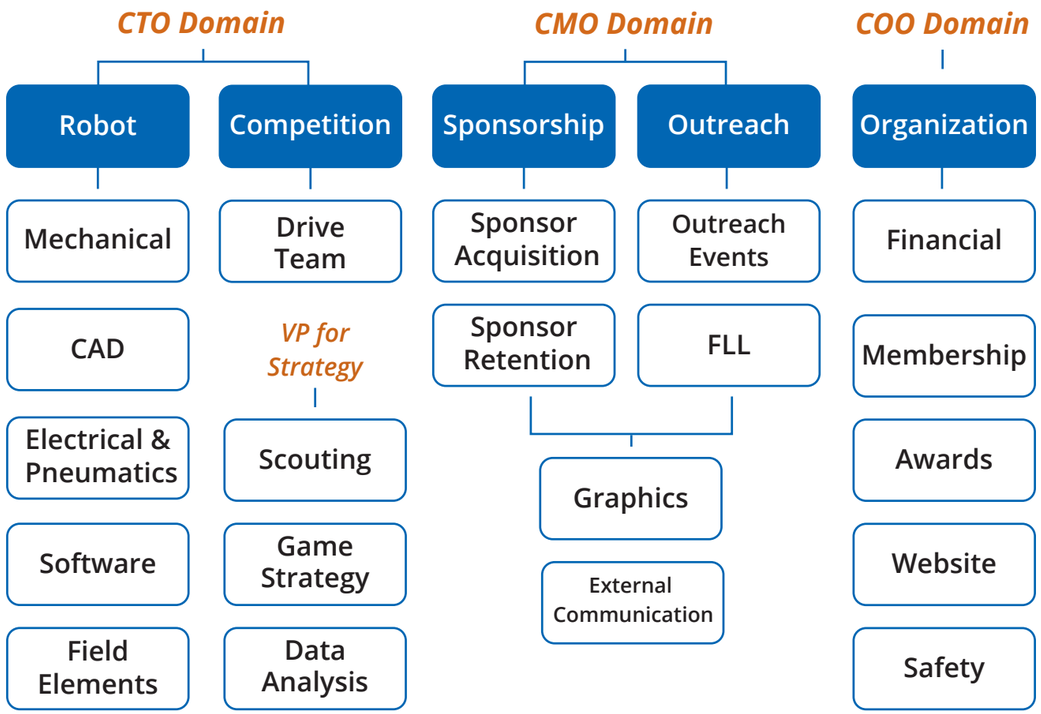
Other considerations (equipment, space, transportation, safety, etc)

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.

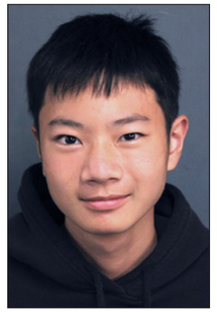
How I Use My LigerBots Skills Out in the World

"I used my LigerBots building skills to make a salinity detector in my chemistry class and to make a model hematoma for nursing students at a summer internship at Northeastern University."

–Aaron

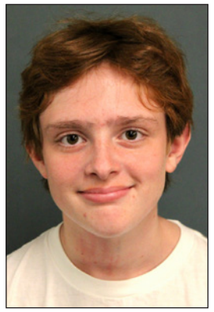
"Managing events such as the FIRST LEGO League steam expo has helped me improve my leadership skills and help others."

–Timothy



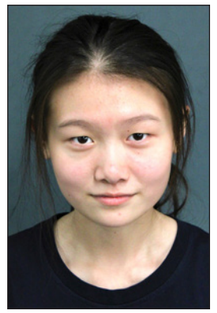
"I used my visualization skills from working on graphics at LigerBots to help design a good website from the scraps of a bad website."

–Yushi



"My mechanical skills help with tasks around the house like installing an entire door all by myself."

–Zach



"I applied the CAD skills and metal materials knowledge I gained from LigerBots to assist my friend in improving their go-kart building project's CAD design and to help them plan the metal purchases."

–Yutong

"I learned trig in LigerBots during my freshman year when making a pumpkin smasher, a whole year before I learned it in school. LigerBots has also taught me how to speak in front of people."

–Julia

"I've used the CAD skills I have learned from LigerBots to CAD a little free library box."

–Evan

"LigerBots programming and teamwork skills helped me with my summer computer science internship, working on the development team of an app builder at MIT."

–Linda

Thaddeus J. Liger, Mascot of Many Disguises

Thaddeus J. Liger, 2008 – 2016

2017, Steamworks

2018, Power Up

2019, Destination: Deep Space

2020, Infinite Recharge

2021, Infinite Recharge at Home: Locomotive Linkage

2022, Rapid React

2023, Charged Up

2024, Crescendo

FRC Team 2877 LIGERBOTS

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