Meet the high school sport that builds robots — and the next generation of engineers.

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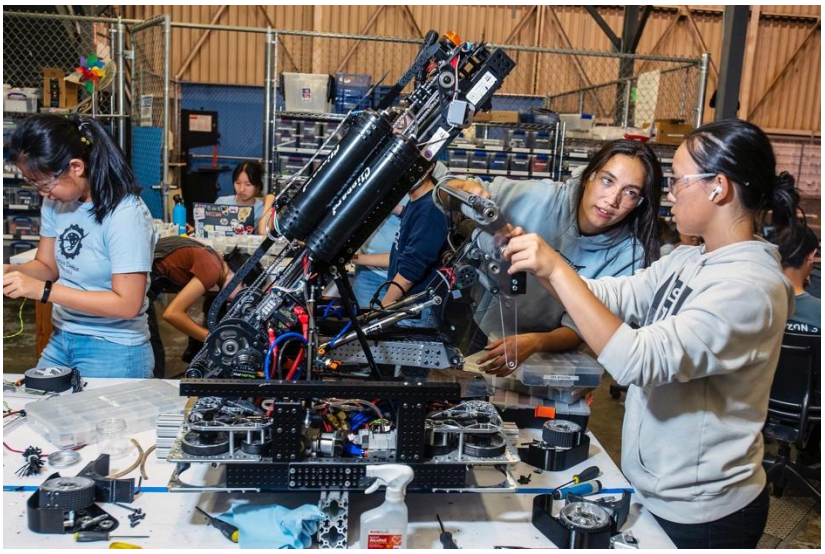
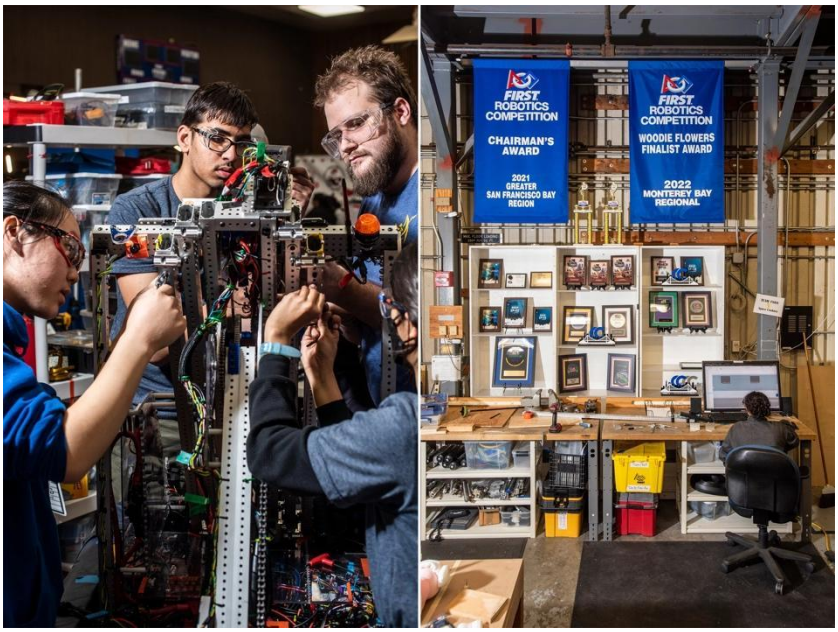


Claire Montegut (second from right), 16, and Anika Zhou (right), 17, are members of the Space Cookies, a *FIRST* Robotics Competition team composed of all Girl Scouts. Here they fix their robot's roller "claw" designed to pick up cones and cubes to score points.

On a Thursday night inside a NASA hangar in Mountain View, Calif., a group of teenage girls cluster around two large tables strewn with wires, hex wrenches and laptops. As they work, a machine rises in their midst — a black aluminum frame loaded with advanced tech like high-powered brushless motors and 3D vision systems. Say hello to the Space Cookies, aka *FIRST* Robotics Competition Team 1868, a Girl Scout troop that builds tournament robots.

Right now, over 3,300 high school and community teams like the Space Cookies are assembling around the world in anticipation of the upcoming season of the *FIRST* (For Inspiration and Recognition of Science and Technology) Robotics Competition. This giant non-profit/sport league started in 1989 as a local program to inspire New Hampshire teens in engineering and technology fields. It has grown to encompass more than 83,000 high schoolers in 31 countries.

Through the fall, students meet outside the school day to develop skills in areas like component milling, gear ratios and Java coding as tools for problem-solving, gamesmanship and intelligence — both human and artificial. Local engineering and IT professionals volunteer as mentors, but older students also teach their younger teammates.



Team 299 Valkyrie Robotics of Cupertino, Calif., tend to their robot in the pit area at the 2023 San Francisco Regional; (left) the workshop for Girl Scout Space Cookies Team 1868 displaying many awards, including a couple of their recent prestigious blue banners.

Some teams take over corridors of classrooms, while others meet in neighborhood garages. Some teams are like student-led companies, with separate departments for public outreach and merch. Depending on their goals and expectations, students may participate from a few hours to a few dozen hours a week.

They are ramping up for January, when *FIRST* will reveal the season's game rules, kicking off a feverish eight weeks of designing, fabricating and programming fresh machines. Then it's onto the three-day regional tournaments that serve as qualifiers for April's world *FIRST* Championship in Houston.

The tournaments are a whirring, banging combination of science fair, Pac-Man and March Madness played by demon-possessed lawnmowers. Robots compete in alliances of 3-vs-3 on a volleyball-sized playing area in two-and-half minute matches. 2023's season-specific tasks involved gathering up yellow traffic cones and inflatable purple cubes to deposit on poles or in slots at either end. Each match starts with fifteen seconds of autonomous action, when robots are programmed to score points on their own. Then, behind a plexi shield, the humans step up to control their mechanical avatars, and it's on – speed, power, grace, defense, teamwork, showboating and the occasional collision with bits of plastic and metal flying around. Yes, those safety glasses are necessary.

Team 5419 Berkelium team members, from Berkeley High School in Berkeley, Calif., test a prototype system to shoot cones onto poles. Caroline Soffer (second from left), 16, is a competitive gymnast and a designer. "I'm never going to be a pro gymnast, while there's a very, very good chance that I'm going to end up in engineering or computer science," she says.

Robotics competitions are nothing new, but over the last few years, the *FIRST* Robotics Competition has evolved from a fascinating after-school activity to having a real impact on the tech and engineering world, and colleges are catching on.

"We like to see evidence of project-based learning, working in teams, hands-on experience and that sense of discovery," says Jennifer Cluett, dean of admissions at Worcester Polytechnic Institute. In 2022, WPI added a custom question to the Common App, asking about students' experience in competitive robotics. Cluett says 218 of 1365 enrollees in WPI's freshman class this year have participated in *FIRST*.

Spartan Robotics control board and pistol-grip controller from 2022, when robots had to catapult giant tennis balls into a basket and dangle from a chin-up bar.

"I was just blown away by these students and their robots, with team logos and t-shirts and buttons, sponsors and cheering sections. It was like Texas high school football," says Jonathan Hoster, associate admissions director at the Syracuse College of Engineering. Two years after he first saw a tournament in 2014, Syracuse earmarked ten scholarships for *FIRST* alumni.

A who's-who list of *FIRST* sponsors — including Boeing, Dow, Coca Cola, Amazon, FedEx, Johnson & Johnson, Apple, Ford, and Disney — shows how eager big businesses are to prime the pipeline. Demand for workers in fields like automation and connectivity, against recent declines in engineering college graduates, makes a resume showing multiple years of hands-on high school robotics increasingly desirable in corporate America.

"Traditionally we would look very heavily at a college GPA. But increasingly companies are looking for more well-rounded employees," says Jody Howard, vice president of innovation and emerging technology at Caterpillar Inc. "What's so interesting about *FIRST* is that, while they may be coming out with robotic or programming skills, it's really the teaming and problem-solving that make them stand out."

Howard compares a *FIRST* team scrambling to put a damaged robot back into the fray with a Caterpillar on-site service engineer cooperating with a client to rush one of their autonomous mining trucks back on line. "They already have experience going through the process under pressure," she says.

Sophomores Adriel Lim and Daniel Kessens monitor the progress of the CNC (computer numeric control) router in the Spartan Robotics machine shop, which also serves as a repository for Team 971's previous robots above.

Lara Fernando is a senior leader on Team 971 Spartan Robotics at Mountain View High School, in Mountain View, Calif. — a few miles from the Space Cookies. Two years ago, she was hired as a paid intern at agricultural technology startup FarmX. "I was the youngest person in the building, 15 years old, and the first woman there. From robotics I already had the skills to be there with the college engineering majors — soldering circuit boards, assembling sensors, running 3D printers."

Besides providing capable personnel, high school *FIRST* teams may also contribute tech back to the industry, from debugging open-source code to coming up with innovative rapid prototyping approaches. At a higher level, engineers who mentor Spartan Robotics say John Deere's weed-killing agribionts now use a middleware framework originally created for the team's 2017 robot to climb ropes and fire Wiffle Balls.

As impressive as these contributions may be, gritty problem-solving is a far more central element of the *FIRST* ethos. Anika Zhou, 16, quit basketball to make more time for design and mechanical work with the Space Cookies. She thinks what sets the robotics team apart from school is, "They let us make mistakes."

Celien Bill, 17, technical manager for Team 5419 Berkelium of Berkeley High School in Berkeley, Calif., estimates he spent over 200 hours last season tuning their cone launching system. "Getting it to work the first time was super exhilarating. That feeling lasts about 10 minutes ... and then you go back to improving."

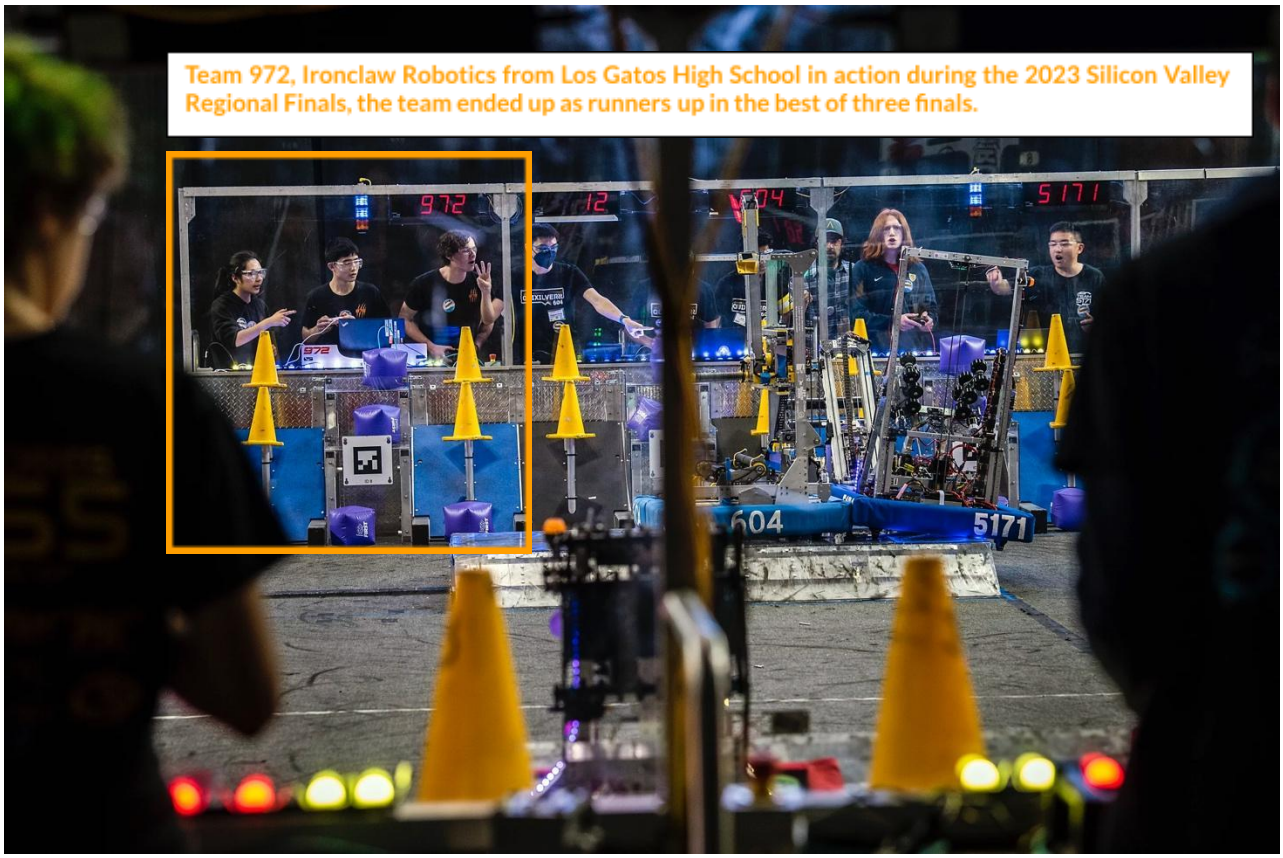
"In the long term, winning and losing have about the same benefit — all the benefit is in the process," says Dirk Wright, lead mentor for Berkelium. "You can't overstate the importance of self-confidence. It opens up a huge amount of opportunities." Plus, it's a lot of fun.

At competitions, there are team flags, zebra-striped referees, huge video screens, people dressed as Vikings and penguins, face paint, singalongs to "Sweet Caroline" and parents in funny hats cheering in the stands. There also are hundreds and thousands of other high schoolers in their team t-shirts, roaming between the pit area and playing field, checking out everybody and every machine.

Team 6238 Popcorn Penguins of Santa Clara County, Calif. won the Team Spirit Award at the 2023 Silicon Valley Regional.

Besides on-field triumph, teams vie for more than 20 other awards, in categories from Rookie All Star to Gracious Professionalism. Only one, the Engineering Inspiration Award, for which sponsor NASA will cover registration fees for the *FIRST* Championship in Houston, has any real material value. The prestige prizes are the blue gym banners that tournament victors and major community award winners can hang in their workshops.

But anybody can take home that warm glow of satisfaction when, in the midst of a big competition, one of their peers walks by, nods and says, "Cool robot."



The finals of the 2023 Silicon Valley Regional: After rushing throughout the match to place cones on poles and cubes in slots to score, the teams earn a large point bonus at the end by cooperating with their alliance partners to balance all three robots on an unstable, tilting platform.