

Robotics Competition: Tomorrow's Tech Talent Has Game

At the FIRST Robotics Competition, teens learn about technology trade-offs, strategy and teamwork. NASA and major tech firms say the contest shapes tomorrow's tech leaders.

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Robotics Rumble: Teens Fight For Tech Glory

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Thirteen years ago, Dan Richardson joined a FIRST high school robotics team not because he was a classic science and technology nerd but because he was tall. As a member of the basketball team at Westminster Academy in Ft. Lauderdale, he was recruited as a "human player" because the robotics enthusiasts needed someone tall enough to reach over a high barrier and drop balls onto the playing field as part of that year's robotics challenge.

"They told me it would mean I could miss school for two days and go to Disney," he recalled. He readily agreed, and found himself at a "technology rock concert" that changed his life, partly because the contest appealed to the same competitive instinct that made him enjoy sports. When he got more involved with the team as a junior, it was because "I was inspired to build better robots than anyone else," he said. "If it hadn't been for the competitive aspect, I don't think I would have been hooked."

The engineering challenge was hard work, "but I knew it was something where I could go pro," Richardson said. Meanwhile, it was dawning on him that his athletic talent for basketball and football might get him a scholarship but probably not a career.

Today, Richardson works as a mechanical engineer at Disney World, designing the next generation of animatronics. He served as an announcer this weekend at the 2013 South Florida FIRST Robotics Competition at the Greater Fort Lauderdale Convention Center. This was one of dozens of qualifying events scheduled between February and early April, leading up to the championship scheduled for April 24-27 in St. Louis.

In this year's Ultimate Ascent challenge, robots competed in a sort of Ultimate Frisbee game, scoring points by tossing flying disks into goals at each end of a field 27 feet wide by 54 feet long. In the first 15-second phase of play, the robots had to be able to operate autonomously, scoring as many goals as possible without human intervention. The remainder of the game was played with the assistance of a driver and a manipulator operator (who controls everything but the maneuvering of the vehicle) piloting the robots across the field to be reloaded with additional flying disks to shoot into the goals. Finally, came the "ascent"

part of the game, in which those robots with the wherewithal pulled themselves up a pyramid of pipes, like a robotic jungle gym, earning bonus points for every level climbed.



Competitors in the FIRST Robotics Competition get their machines ready to rumble.

As the game advances into the finals and semi-finals, the teams organize into larger alliances, and it's actually an alliance of three teams that wins. In the Fort Lauderdale competition, the victorious alliance included three Florida teams: S.P.A.M. of Stuart (the 2012 world champions), Exploding Bacon of Winter Park, and the Tech Tigers of Coconut Creek.

The challenge is different each year, so one year's winning robot would not necessarily do well in the following year's contest. When this year's challenge was announced in January, teams had six weeks of "build season" in which to go from initial sketches to CAD drawings, prototypes, final hardware and software and a complete working system. After six weeks, teams must observe a "hands off" policy except during a competition when a pit crew can make additional adjustments before the start of play and between rounds.

The [FIRST \(For Inspiration and Recognition of Science and Technology\)](#) program started in 1992 as the brainchild of Dean Kamen, best known as the inventor of the Segway, the versatile Independence robotic wheelchair, and other medical devices. His idea was to expose students to concrete engineering challenges, while having professional engineers encourage and mentor them. This year's FIRST Robotics Competition (FRC) event for high school students has about 54,000 high-school-aged young people organized into 2,700 teams, with the support of about 16,000 mentors and adult advisors and 3,000 corporate sponsors. While FRC is the major event, the program has expanded over the years to also include the FTC (First Tech Challenge) program for grades 7-12, FLL (First Lego League) for grades 4-8, and Jr. FLL for grades K-3.

NASA is a major sponsor because of its interest in [better robots for interplanetary exploration](#). Major

aerospace and technology firms, including embedded systems software specialists, also provide support. Participating students also get a shot at the \$16 million in scholarships being offered through FIRST this year.

Richardson said corporate support tends to come from engineering-oriented firms who want to produce their next generation of employees. Even in the worst years of the recession, employers reported a shortage of engineering talent, he pointed out, and unemployment in the sector is extremely low. He stays involved in FIRST because he wants young people to recognize the opportunity the program presents to get a head start on an engineering career. Besides, it's something that can "make them rock stars in school," he said. While still a college student in the engineering program at the University of Central Florida, he helped found Exploding Bacon.

Many advocates see FIRST providing experience young people simply couldn't get at school, even in a program that emphasizes science, technology, engineering and math (STEM) disciplines. Practical skills include mechanical and electrical design, working with professional design software, making custom parts, and assembling the robot, as well as doing embedded system programming.

"For everything you see that moves, there are probably a thousand lines of code," said Jade Zsiros, a S.P.A.M. programmer last year who returned this year as team captain, dressed in the team uniform of blue tights and a superman cape. The coding alone took about two weeks of work with three programmers, she said.

FIRST competitors who go on to college engineering studies report that the first projects they are assigned "are a snap" for them, while other users struggle, said Richard Brooks, an adult leader and engineering mentor for S.P.A.M., a team that will be defending its world champion title in St. Louis this year. They learn how to take a concept and turn it into reality, with real-world constraints like time, budget and materials. "They learn how to apply STEM principles in a real-life situation," he said.

For example, one critical decision teams had to make going into this year's competition was how much to optimize their robots for climbing versus speed, maneuverability and the ability to throw flying discs. Brooks said he thought his alliance had struck a good balance, with each robot able to climb on the first rung of the pyramid tower and hang there, a feat worth 10 bonus points. Each machine also boasted good throwing power. Also, when the important autonomous phase of play started, the rules required the robots to start out touching the central pyramid towers.

Exploding Bacon had built its robot squat enough that it could duck under the tower and scoot closer to shoot discs into the high central goal, which is worth more points, and all goals scored during autonomous play count double. Meanwhile, the Tech Tigers robot was one of the few dexterous enough to pick discs off the floor and throw them, rather than retreating to the other end of the field to be resupplied.

The Ninjineers, a team from American Heritage High School in Plantation, Fla., made different choices and wound up with the only robot at this competition that consistently climbed to the third rung of the tower.

"We had the only robot in the whole competition that has been able to climb to the 30-point level, and we've been doing it all weekend," said John Vermes, a teacher in the school's engineering program who serves as a mentor to the team. Like capturing the Golden Snitch in Quidditch, this is a move that tends to be decisive. The secret to their design, he proudly pointed out, was a climbing arm that also served as a flying disk launcher, in contrast to the separate mechanisms many other teams had built for those two tasks.

Yet in a semi-final round, with victory hanging by a thread, the alliance the Ninjineers had joined was betrayed by a bit of string. Although the robots from the other two teams hadn't climbed as high, all had lifted themselves off the floor. However, the umpire responsible for checking that none was touching the

ground at any point found a bit of string hanging from one of them and invalidated that 10-point bonus. It was just enough to change what would have been a win into a loss, by a margin of two points.

"We'd been hoping to go to St. Louis," Vermes said, sadly. Win or lose, the competition teaches things that are hard to convey through school exercises, he said. "A robot is a lab unto itself -- it's reality, not theory, and it has to work. To succeed, to win, it has to be high quality." The robot also has to be their work, not his, he said. "I only do the welding."

S.P.A.M.'s Brooks said he has a few team members who are athletes like Richardson but most are "the nerdier kids." Part of the value of the program is to make them more well-rounded, he said. Even as they stretch their math and science skills, they also are learning to communicate better and work in teams.

"When they come in as freshmen, they're talking to their shoes," Brooks said. Yet to do well in FIRST, they not only need to build a great robot, they also need to be able to sell sponsors and ultimately the judges on why their robot and their robotics team are so great.

Kristopher Walters, co-president and driver for Exploding Bacon, came into the program as a home schooler, and he said one of the things that it taught him was "how to talk to people." No, that doesn't mean he was shy, not exactly, he said. "I loved people, I just didn't know how to talk to people. Or, being yelled at on the field, but in a friendly way -- I didn't know how to handle that." Yet with practice, he learned to talk, persuade, banter, and cajole -- and give as good as he got when others teased him.

Exploding Bacon at the FIRST Robotics regional ...



Exploding Bacon co-president and driver Kristopher Walters explains the design of a championship robot.

"Anyone here will tell you, it's not about the robot," said Wendy Austin, one of the adult advisors to Exploding Bacon and a member of the regional council. "They learn critical thinking, design, engineering, marketing, business and how to write a press release. We have an annual budget of about \$68,000, so they have to learn how to go to a CEO and make a presentation. They're not shy about asking for it."

The amount of money involved is one of the things that tends to scare off potential team organizers, Austin said, admitting "the first year is the hardest because you don't have a robot to show people." The rules stipulate that teams can spend no more than \$4,000 on the robot itself, and no more than \$400 on any

individual part, but other expenses such as travel and shipping mount up fast.

Yet once the students learn the business part of the operation, they become the answer, Austin said. "If I can get them in front of a CEO, he's not going to say no." NASA makes grants available specifically to help new teams get started, she said, and many other grants are available once you learn where to look for them.

Austin knows from experience that the effort is worth it. As a direct result of involvement in FIRST, her younger daughter wound up getting three internship offers while she was still in high school, along with a \$20,000 scholarship to study engineering at Embry-Riddle Aeronautical University, she said. "I stopped being able to help her with math in fifth grade."

Austin said there are four ways she sees teams being organized:

- As a direct outgrowth of a school STEM program, where building the robot is part of a class.
- As an after-school program.
- As a university-sponsored program, with engineering students and faculty as mentors.
- Under the umbrella of another youth organization, such as Boy Scouts, Girl Scouts or 4H.

Exploding Bacon is a 4H Club, which allows it to draw on four high schools plus the local population of home schoolers, she said. Many of the leading clubs at the South Florida event actually seemed to be community-based groups, rather than being attached to a specific school. That's also true of S.P.A.M., although the third team in the winning alliance, the Tech Tigers, is anchored at the Atlantic Technical Center Magnet School.

The Dirty Mechanics of Boca Raton bounced back as a community-based team after losing its official status as a club at Boca Raton High School. Now, the team continues to draw most of its members from the high school, which has a competitive STEM magnet program, but has also pulled in students from other schools in the community as well as a number of home schoolers.

That presented its own challenges, said Nick Middlebrooks, the student technical leader on the team. "The home school kids didn't know how to use power tools, how to drill, how to wire things, how to do programming," he said, but now they do. "Everyone on the team knows at least the basics of how to build."

"We've had a lot of issues getting funding," said team captain Erin Ferguson, explaining that she wound up with a budget of about \$12,000, including help from the local Rotary Club and JC Penney, as well as funding and in-kind donations and mentorship from Tyco. When the team members were designing their flying disk launcher, they developed the prototype in plywood and then their mentor from Tyco turned it into sheet metal, she said. "He machined the parts, but we assembled them."

For their efforts, they got a robot that performed quite well, with the ability to shoot from anywhere on the field and push other robots around with high-torque on its wheels. Although this didn't translate into a victory, the Dirty Mechanics walked away with the Judge's Award for "extreme resilience."

Keeping the club alive was a learning experience all its own.

The Dirty Mechanics of Boca Raton at the FIRST ...



Dirty Mechanics technical lead Nick Middlebrooks, team captain Erin Ferguson (in the tiara) and operations head Kendall Manning on their robot, their strategy and how to create a great team.

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