

# Science Fair Season

*Twelve Kids, a Robot Named Scorch . . . and What It Takes to  
Win*

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## INTRODUCTION

One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike— and yet it is the most precious thing we have.

—MARK TWAIN

The cockroaches were the size of cell phones. They arrived, alive, via priority mail. After dumping them into a tank, fifteen-year-old Tristan Williams painted numbers on their backs, 1 through 20, to tell them apart. He fed them chicken feed and table scraps, noting that the only food they refused to eat were Krispy Kreme donuts. This made him wonder: *Do these roaches know something about Krispy Kreme that we don't?* Interesting question. But right now, Tristan had more pressing priorities.

It was March, a month that kicked off a series of competitions that Tristan adored more than any other: science fair season. Tristan, a brainy, bespectacled high school sophomore plagued with poor athletic skills, had long ago embraced science as his sport. He'd competed in science fairs since kindergarten and had come in first every year but fifth grade. The secret to his winning formula? Insects, of course. In first grade, having discovered that ants detest the smell of catnip, he created an insect repellent out of the plant that kept flies off his sister's horse. In sixth grade, after reading that pill bugs devour poisonous chemicals such as lead and cadmium, he conducted an experiment proving the bugs could be used to clean up toxic waste sites. In ninth grade, after hearing his mother gripe about a flour beetle infestation in her pantry, he found a way to keep the beetles at bay using buffalo gourds. Tristan's ingenuity in this realm was unrivaled. Trophies and blue ribbons lined his bedroom walls. He'd even ascended the ranks to win regional and state fairs. This year, though, Tristan was determined to take his project all the way to the top.

That's when cockroaches—specifically, Madagascar cockroaches—came to mind. Tristan had read that these insects had two unique things going for them: a keen sense of smell and the ability to hiss loudly when threatened. Since Tristan's hometown of Las Cruces, New Mexico, was located fifty miles from the Mexican border, cops regularly conducted drug checks along highways and in schools. Drug-sniffing dogs, Tristan learned, were expensive, costing \$25,000 each to train. This got Tristan thinking: Could Madagascar cockroaches be trained to hiss when exposed to certain odors? And if so, couldn't law enforcement ditch drug-sniffing dogs for the much cheaper alternative of drug-sniffing cockroaches?

It was a flash of science fair genius, the kind of moment Tristan prayed for. Still, a brilliant idea was just the first step. If Tristan's project was to take off, he'd have to tackle a whole series of tricky problems. First up: the drugs. Tristan knew his parents wouldn't approve of him having a stash of marijuana, even for purely experimental purposes. And besides, the use of illegal substances was forbidden at science fairs unless you filled out tons of paperwork. So Tristan cast about for an alternate odor that would still prove his point. Spotting a felt-tipped pen on his desk, he picked it up, uncapped it, and sniffed. *This will work*, he decided. After meticulously laying out the parameters of his experiment, Tristan was ready to wrestle with an even bigger question: Were roaches trainable? It was time to find out.

Tristan reached into his tank, fished out Roach #1, and placed it in a shallow Tupperware bowl to keep it from scuttling away. Uncapping the pen, Tristan waved it in the roach's vicinity; then he poked the roach with a finger, prompting it to hiss. Tristan repeated this exercise—the pen, the poke, over and over—to see if the roach could be conditioned to hiss in response to the pen's fumes alone. After eighty-five rounds, the roach got the drift, proving that Tristan's hypothesis was right on the money. Elated, Tristan trained twenty roaches total, recorded his results, and wrote a paper describing the potential applications for drug detection. He knew the odds were slim that cops would take note and start replacing dogs with bugs. Still, stranger things had caught on.

Weeks later, at a local science fair, Tristan presented his project. While it raised a few eyebrows, the judges were nonetheless impressed. Tristan was awarded first place, which propelled him to the state level. Tristan won there as well, which meant that finally, with a decade's worth of projects behind him, Tristan had broken into the big leagues. *The New York Times*, catching wind of his experiment, nicknamed him Cockroach Boy. TV news crews flooded his home to film the roaches in action. Tristan even heard that scientists in nearby Los Alamos had played off the same principle and trained a hive of bomb-sniffing bees. There remained just one final hurdle he would need to surmount to claim everlasting fame on the science fair circuit: He'd need to fly to Cleveland, Ohio, and compete at the Intel International Science and Engineering Fair (ISEF).

Intel ISEF is the Super Bowl of science fairs. Every year, more than fifteen hundred high schoolers from more than fifty countries convene to fight for more than \$4 million in prizes and scholarships. Given that this was the top of the science fair pyramid, Tristan knew that the competition would be fierce. But only once he entered the convention hall and trolled the aisles did it dawn on him what he was up against. In one corner of the hall, a girl with glasses explained how she'd synthesized a drug that slowed the growth of cancer. In another booth, a team of three boys from Brazil wowed audiences with a *Terminator*-style bionic arm. In another corner, genetically engineered plants promised to put an end to world hunger. And those were just the projects Tristan

could figure out. For some, the title alone—e.g., “Endogenous Estrogen Amplification Through Interaction with P450 Enzymes: Novel Mechanisms for Xenoestrogenicity”—was enough to make his head spin.

Taking it all in, Tristan started to sweat. Trained cockroaches would look downright pathetic next to these scientific opuses. In spite of all his hard work, in spite of his patience putting up with the wisecracks and roach jokes from kids in school, Tristan would return home empty-handed. He didn't stand a chance.

Or did he?

Science fairs bring back memories for just about all of us. The petri dishes. The potato clocks. The classic, crowd-pleasing baking soda volcanoes. Back in fifth grade, my science fair project consisted of rocks dug up in my backyard and pasted on a cardboard display. It didn't win, but I was proud of my work. One day, I dreamed of being a scientist myself.

Flash forward twenty-some years. I was a journalist in New York, surfing the Web, when I stumbled across a *New York Times* article about Tristan Williams and his drug-sniffing cockroaches. Something about his story—his creativity, his drive—fired me up. Like a high-IQ *American Idol*, science fairs were a stage where kids like Tristan could strut his stuff. I was rooting for him, and sad to discover, with further digging, that Intel ISEF did not find him worthy of an award. How could this be? Was the competition really that stiff?

On May 10, 2009, I flew to Reno, Nevada, where Intel ISEF 2009 was taking place. As I strolled through the aisles, it didn't take long for me to see why trained cockroaches didn't make the cut. The first thing I spotted that threw me off guard was a nuclear fusion reactor, which fused atoms together using the same principle that powers the sun. A few booths down, I marveled at a student who had genetically engineered “smart worms” that could do things a worm had no business doing. Next to that, one student's nanotechnology project had led to five patents and a company slated to rake in \$12 million. At every booth, I had to pinch myself as a reminder that kids—kids!—had come up with this stuff. And I wasn't the only adult who'd roamed through this surreal sea of tri-panels and left impressed.

“High schoolers are now solving problems that have puzzled scientists for years,” says Larry Bellipanni, professor of biological sciences at the University of Southern Mississippi, who's attended fairs for more than forty years and conducted studies on their participants. Andrew Yeager, who's judged science fairs for thirty years and is a professor of medicine at the University of Arizona College of Medicine, seconded this notion, adding, “The level of sophistication in these projects is in many cases beyond the level of graduate school and doctoral research.” Hoping to tap into this font

of creativity, representatives from the National Institutes of Health, federal agencies, elite universities, and other organizations have walked the aisles of science fairs searching for fresh talent and ideas, and they've found plenty.

Take plane crashes. In 2009, after a U.S. Airways plane landed in the Hudson River due to engine failure caused by birds, aeronautics engineers redoubled their efforts to invent a bird radar system that could alleviate the problem. Katie Stine, a seventeen-year-old in Hilton Head, South Carolina, created a much simpler solution: a meshlike metal cone that can be placed over the front of the plane's engine and would allow air through but deflect obstacles in its path. Given that testing her device on a plane wasn't an option, Stine devised a way to simulate the same conditions using a tennis ball machine, firing a flurry of one-hundred-mile-per-hour balls at the cone to mimic bird collisions. The resulting prototype racked up numerous awards at science fairs and may soon have a patent. Which is not at all unusual: One in five national science fair contestants have patents pending for their projects.

Students who hope their science fair projects may one day impact the world aren't being naive. When NASA launched their Galileo spacecraft toward Jupiter in 1991, they planned a picture-snapping flyby of the asteroid 951 Gaspra, using data collected by seventeen-year-old Claudine Madras from Newton, Massachusetts. Treatments for ailments from autism to Alzheimer's have also benefited from the contributions of science fair contestants. After Gainesville, Florida, seventeen-year-old Kyle Jones discovered that a substance called conjugated linoleic acid kills 90 percent of colon cancer cells within three days, the M. D. Anderson Cancer Center used his research as a springboard for further experiments. Even the Pepsi you get from a vending machine may soon be safer thanks to Taylor Jones, a sixteen-year-old from Alcoa, Tennessee, who patented a germicidal light that can kill microbes lurking on the can as it's dispensed.

Cancer cures and cleaner Pepsi cans aren't all that's at stake. Some experts argue that the very future of our country rests on these kids' shoulders. According to a recent report by the International Center for Education Statistics, American fifteen-year-olds scored significantly lower in science literacy than students in China, Japan, Canada, the Czech Republic, and eighteen other countries. The Hart-Rudman Commission, tasked with finding solutions to national security threats, concluded that the failures of our math and science education "pose a greater threat . . . than any potential conventional war." Even Bill Gates is scared, having addressed a summit of state governors by saying, "When I compare our high schools to what I see when I'm traveling abroad, I'm terrified for our workforce of tomorrow."

Science fairs, unlike high school sports, rarely fill the rafters with raving fans. But the tide is turning. In 2009, President Barack Obama announced that the White House would begin holding an

annual science fair in an effort to move the United States “from the middle to the top of the pack in science and math over the next decade.” After all, the President pointed out, “If you win the NCAA championship, you come to the White House. Well, if you’re a young person and you’ve produced the best experiment or design, the best hardware or software, you ought to be recognized for that achievement, too. Scientists and engineers ought to stand side by side with athletes and entertainers as role models, and here at the White House, we’re going to lead by example. We’re going to show young people how cool science can be.”

As I wandered slack-jawed through the aisles of Intel ISEF 2009, I wasn’t just bowled over by the sophistication levels of the projects. What hit me even harder were the stories behind them. Many of the kids had been inspired to solve problems in their own lives. One boy, whose family was scraping by in a derelict trailer with no heat or hot water, designed a solar-powered heater out of a 1967 Pontiac radiator, sixty-nine soda cans, and other junk he found around town. Another girl, hoping to help her little cousin cope with autism, developed a treatment program that enabled her cousin to read, write, and interact with others, and proved so successful that it was rolled out in schools across the country. In another town, where local cops had been rattled by a rash of suicides, a science fair project involving “therapy horses” helped keep post-traumatic stress at bay.

In addition to tackling the intricacies of particle physics and thermodynamics, these kids encountered obstacles outside the lab that would make even the most stalwart competitor crumble. One girl, after raising awareness about a cancerous chemical being dumped in the water by the multibillion-dollar company DuPont, became a terrorist suspect under investigation by the FBI. Other kids stumbled across more pleasant surprises, like \$420,000 in prize money, a trophy case next to the football team’s, and the chance to ask a girlfriend to the prom on *Good Morning America*. As I rode along through their highs and lows, I saw not only how these kids were transforming the world, but how the experience was leaving an indelible mark on them and who they’d one day become. Thanks to science fairs, two boys sitting in a juvenile detention facility learned they were smarter than they thought. A girl with leprosy discovered that even the most devastating disease had an upside if you looked for it. Science fairs gave them confidence, and courage, and hope.

Inspired by the kids I met at Intel ISEF 2009, I stayed. Over five days, I watched them set up their projects, field questions from judges, then take their seats at the awards ceremony to see if their dreams of science fair stardom would come true, or crash and burn. Out of 1,502 registered competitors, I met six who captivated me so much, I dedicated six chapters of this book to documenting their journeys. The other five chapters are devoted to past competitors whose stories are the stuff of legend in science fair circles. Curious whether the rumors I’d heard about these

students' exploits were true, I made pilgrimages to their homes and laboratories, and was amazed by what I saw.

Science fairs are full of surprises. But there are no guarantees of a happy ending. Some of the competitors profiled in these pages will win. Others will lose. But win or lose, science fairs change kids. And even though I was just an observer, rooting on my six Intel ISEF 2009 competitors from the sidelines, I'd say that science fairs changed me, too.

In a world brimming with bad news—global warming, nuclear proliferation, America's alarming decline in the realm of science education and otherwise—science fairs are the silver lining. They convinced me that maybe we're not as bad off as I might think. While writing this book, I got to know the most hardworking, humbling, and heartbreaking group of young men and women. They changed everything I thought I knew about kids and what they're capable of, and what we can all do if our hearts are into it, at eight years old or eighty.