Intel ISEF—Profiles of Success

Enjoying a Brilliant Experience

What Students Gain From Participating in Fairs

It's hard work to complete an independent research project and answer the questions that knowledgeable judges ask. These motivated students not only rise to the occasion, but thrive on the experience. At national and international competitions, they also get the chance to meet with other young people who share their passion. No wonder so many participants describe the science fair experience as "the best week of my life." Here's what a few fair veterans have to say about the experience.

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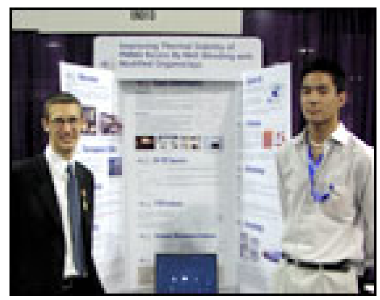

An Experience That 'Opens Up Worlds'
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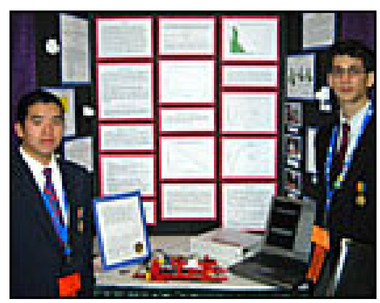

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An Enriching Experience

Amanda Hersh, Dilruba Akther, and Rogaite Shafi

Through a summer science enrichment program, three girls from different high schools in Brooklyn, New York, teamed up to work on an engineering and robotics project that could save lives in combat or when emergency crews respond to natural disasters.

The teams members are Amanda Hersh, 15, from Yeshivah of Flatbush Joel Braverman High School; Dilruba Akther, 17, Fort Hamilton High School; and Rogaite Shafi, 17, from Brooklyn Technical High School. They met during a summer program at Polytechnic University in New York, where they discovered a shared interest in science and engineering. “We started brainstorming ideas, and this one seemed like the most practical,” explained Hersh.

The engineering project that took them to the 2005 finals of Intel ISEF involves a webcam that can tilt and rotate to provide views of several robots. “That means you can see everything from the Internet, without having to physically be on the scene,” said Shafi. “This could improve safety in combat, or possibly help the elderly who need help with mobility.”

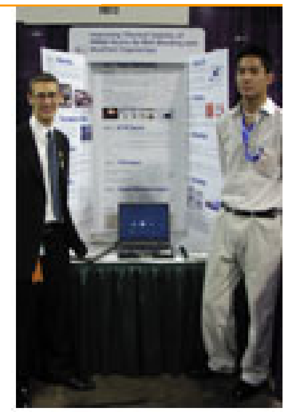
The idea took root when they saw a webcam being used in a lab setting to view a single robot, and envisioned cost-efficiencies and better results if the webcam could rotate to view multiple robots. Getting their idea to work involved designing a platform that could rotate and tilt, solving circuitry problems, and working out programming challenges. Each team member brought unique insights to the project. Explains Akther, “Rogaite was the programmer, Amanda worked with the hardware, and I dealt with circuitry and wiring.”

The summer program and team effort reinforced their interest in science and engineering. “Engineering is not just a guys’ topic,” said Hersh. “Everything today is technology related,” added Shafi, who is contemplating a career in astronomy or medicine. “Wherever I wind up, I’m know I’m going to need to know about technology.”

For all three girls, one of the highlights of Intel ISEF was the chance to hear American astronaut Sally Ride. “We had our picture taken with her,” said Akther. “That was amazing.”

An Experience That 'Opens Up Worlds'

Jonathan Hefter and Andrew Song



Jonathan Hefter and Andrew Song, both from Long Island, New York, had never met before they attended a summer scholars program and teamed up to work on a research project. Now, they share in the ownership of a patent for the engineering discovery that came out of their research. At Intel ISEF 2003, they won fourth place in the engineering category for their project, "Improving Thermal Stability of MMA Resins by Melt Blending With Modified Organoclays."

Jonathan Hefter

Hefter, 17, attends Davis Renov Stahler Yeshiva High School for Boys, a small private Orthodox Jewish school located in Lawrence, New York. Song, 16, attends Jericho High School, a public school in Jericho, New York. During a summer high school scholars program at the State University of New York at Stony Brook, Garcia Center, they began working on a project that may have life-saving applications.

Hefter offers an overview: "Fires have always been a major problem, and one of the biggest problems is the speed at which fires spread. For example, in the Rhode Island nightclub fire that happened a few months ago, the whole building was engulfed within three minutes. Flammable paints, coatings, and adhesives may quicken the spread of fire and lead to increased fatalities. The vast majority of these paints, coatings, and adhesives are acrylic-based. Basically, we've tried to slow down the speed at which certain materials will burn."

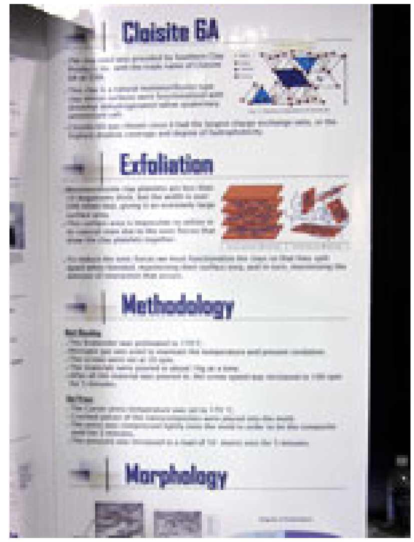
Developing Their Idea

Their project idea was sparked by what they learned during the summer research program. Professor Miriam Rafailovich, director of the Garcia Center for Polymers at Engineered Interfaces, explained to them the potential of a material called thermal plastic olefin, or TPO. "It's going to replace a lot of the parts on cars," Hefter predicts. "This technology promises to produce cars that are light, inexpensive, and resistant to corrosion; however, repair of these cars relies on the use of acrylic resin adhesives, known to have low temperature flash points. But when TPO cracks, the only bonding agent that's effective is an acrylic adhesive. That's the same material that was used in the paints on the walls in the Rhode Island club. It's a safety hazard."

Through experimentation and lab testing, Hefter and Song have developed a way to make a resin that is more flame retardant, or at least slower to burn. Their approach mixes a clay with the acrylic resin. "It's inexpensive to produce," Hefter adds, "which would make it commercially feasible." Their lab tests showed that increasing the material's flame-retardant qualities did not affect adhesion, and may represent an advancement in the safety of acrylic materials.

Learning in Tandem

Although the students were thrilled with their results, getting to the finish line meant overcoming hurdles and learning to work as a team. "We were both new to the field," Hefter says, "so it was a challenge to both of us. But at this point we know more about our project than we ever thought we would."



After the intense summer program ended, they continued working on their project, writing their research summary and preparing a poster for competition. "It was a mad dash to put a paper together," Song admits. "We went through several boards, getting our poster done. It was hard."

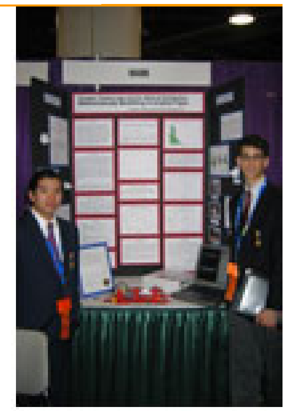
Neither was experienced at entering science fairs, but they performed so well at the Long Island Science and Engineering Fair that they earned a trip to Intel ISEF. There, they noticed a jump in intensity. "We had eight judges come by our booth in less than two hours," says Song. "And they ask more questions, better questions, at Intel ISEF."

Worth the Effort

The experience has been well worth the effort, according to Hefter. "This is definitely something that opens up worlds. And it's not just for people who spend their days in their basement making circuit boards. At Intel ISEF, there are so many cool people. And it really opens up a lot of doors. For example, now I'm dealing with companies. We have a patent, and we're trying to sell the product. We've had so many new experiences. It's not just about the science. It's about getting out there in the world."

Pooling Their Talents

Andrew Michael Leifer, Raymund Chun-Hung To, and David Guillaume Pothier

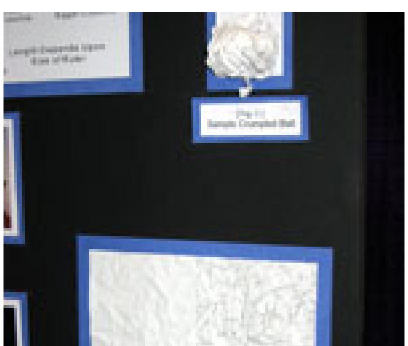


Looking back, Intel ISEF finalists Andrew Leifer, Raymund Chun-Hung To, and David Pothier can't imagine completing their research project without each other's support. The three students from Fairview High School in Boulder, Colorado, conducted their team research project on the mathematical properties of crumpled paper. It turns out to be a topic with interesting applications in the field of energy. But gathering data meant hours of crumpling paper and measuring ridges. "How could any of us possibly sit and do that alone?" asks Leifer.

Getting Started

Instead of starting with a topic in mind, the students began the research process by forming their team. Leifer liked the idea of a team project, he says, "because you could divvy up the workload. You could do more and go further." A team project also offered them a chance to harness each participant's strengths. Leifer describes the dynamics this way: " I like understanding why things happen. That's my big thing. Ray (Chun-Hung To) is more the engineer of the group. And David (Pothier) is just one of those guys that you can get along with." Pothier also understands fractal theory, which became an important part of their project.

They agreed that not just any topic would do. "We want to do something that matters, something that's original research, that's cutting edge," says Leifer. "But it also has to be something that you can do from your home," without access to laboratory equipment.



When Leifer's father suggested they look into the properties of crumpled paper, they first thought he was joking. "My dad had studied physics in college. He just started reading journals and was saying look at this, look at this, look at this. And we were like: No, no, no. But then we were like, well, maybe. Actually, that's not so bad as an idea."

The students did some preliminary research using the Internet and decided to take on the challenge of developing a mathematical model for how paper crumples. Their project, "Fractals, Power-Laws, and the Weibull Distribution: Mathematically Modeling Crumpled Paper," wound up winning at the regional level and landing them a trip to compete as finalists at Intel ISEF 2003.

Lessons Emerge

One of the lessons to come out of their project, Leifer says, is "never discredit the little things." Studying something as simple as how paper crumples turned into a project about physics, mathematics, energy absorption, and statistics, among other things. Leifer explains: "Crumpled paper is a membrane and membranes act the same way, so crumpled paper acts like crumpled metal, which acts like a car crashing. Every time your car crashes, your building falls, or you have to package some material, it's all about energy absorption and crumpling. And the math behind it isn't fully researched. There's a lot of unanswered questions regarding it, and it's a wonderful opportunity to do a whole lot of research that's simple."

Although excited about the topic, they had to endure monotony during the data collection stage of their project. Leifer describes the protocol: "You'd crumple the ball, and then you'd go through and you unfurl it, and you take your ruler and you go through and measure every single ridge length. And we actually did it with a pencil and sometimes a magnifying lens." Chung-Hung To turned out to be the most consistent at measuring paper ridges, so he took over most of that process. To keep things interesting, they played a tape of Brazilian music that became their theme song.

Surprising Results

Once they had gathered their data and conducted more research, they moved forward with analysis. Analyzing the data required them to learn more about statistics. They consulted online resources and interviewed professional statisticians to gather strategies for how to proceed. Eventually, they were able to develop a model that describes what they observed in mathematical terms.

As Chun-Hung To explains, the students' findings add new information to existing research in the area of energy absorption: "One researcher had found that if you were given the length of a single ridge, then he could tell you the amount of energy necessary to crumple that. There was another researcher who used different materials, and found that in terms of the power loss, you get the same relationships. Obviously, it's going to take more energy to buckle a steel beam than it takes to crumple paper, but the equations describing them are the same."

Because of the length of the individual ridges is part of that equation, the students recognized the importance of finding a ridge-length distribution. Chun-Hung To explains the significance: "When we crumple a ball, we wanted to see how many ridge lengths of five millimeters show up, how many of three millimeters show up, and so on. Put the data of the total number of ridge lengths together with the energy per ridge length, and you'll get energy in a crumpled ball and therefore energy in a sheet of paper, and then that'll move on to energy in a sheet of metal."

They succeeded in gathering the ridge-length data and plotting it to a histogram. "If you crumpled a sheet of paper right now and you told us the radius, we could tell you how many ridges you'd get, the size of all those ridges, all that great stuff," Leifer says.

"But that's not the coolest aspect of this project," he adds. "The really cool aspect is that, each step of the way, we were able to find math that corresponds exactly to the physical process. So every step of the crumpling process, we have the math working, paralleling directly the physical aspect. For example, crumpling paper is mathematically identical to crunching up rocks, which involves geophysics. We found all kinds of cool relationships that we weren't even looking for, and those are all brand new. It's extremely useful. Things worked really, really well, far surpassing our expectations."

Worth the Effort

Was the project worth all the effort? "Oh, yeah," says Leifer. "It was so much fun. It was a great learning process."

As they head toward college, the three students hope to publish their findings and continue with new research. Chun-Hung To says the next logical step would be to find a way to automate the crumpling process. "Then we can use computer programs and scanners to get more data. Even though we do have good statistical backing, we want even more statistical backing and that comes with more data points. So that's the first step. And then further down the line there's always more analysis about how this relates to energy."

Adds Leifer, "Even if I don't specifically carry on with this research, the stuff I've learned already is just going to help me so much. Most of all, we've learned that you just have to be really resourceful."