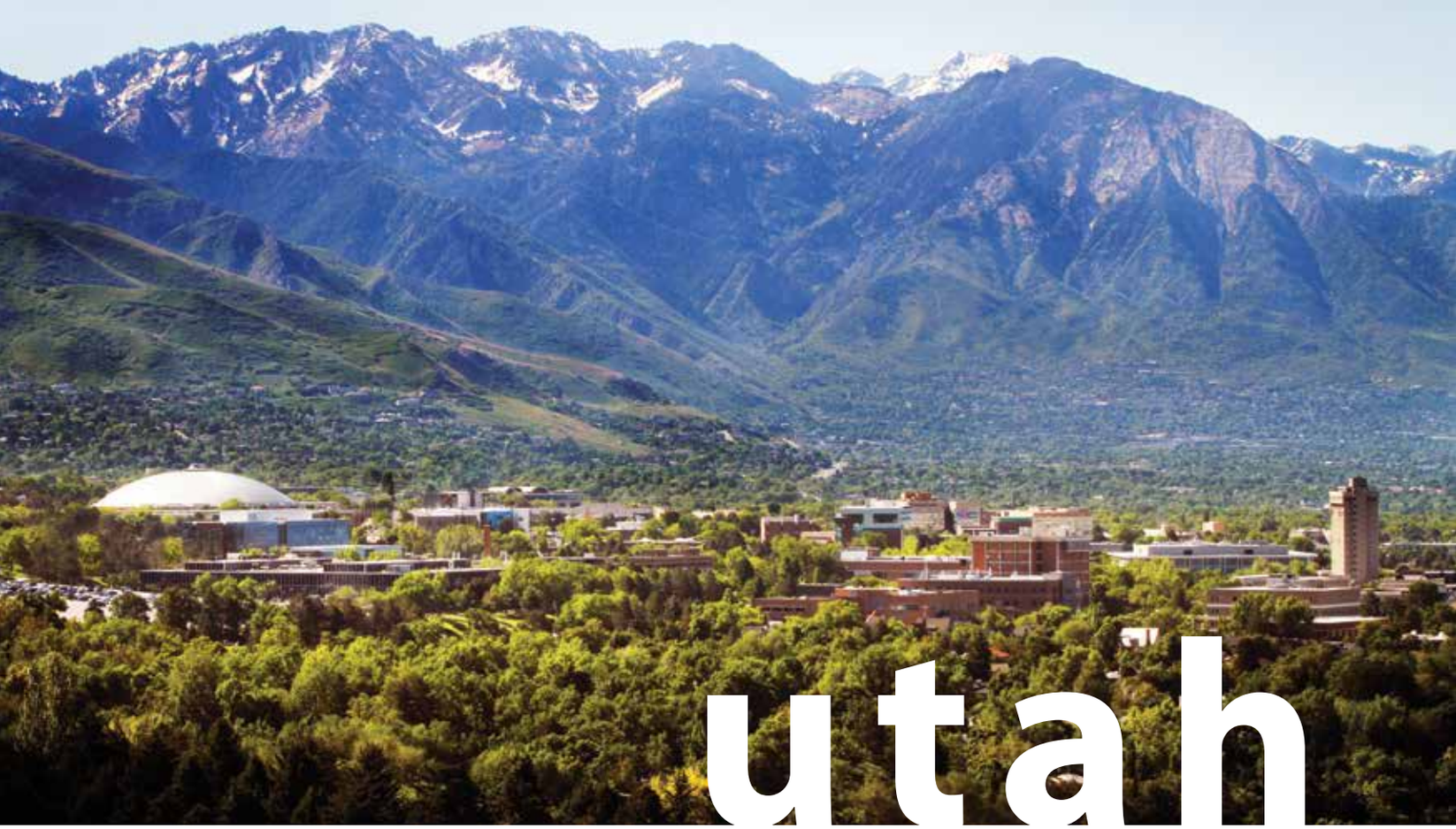

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INSPIRING FUTURE ENGINEERS

THE UNIVERSITY OF UTAH • COLLEGE OF ENGINEERING NEWSLETTER

SPRING 2014

INNOVATING ENGINEERING EDUCATION

On a crisp spring morning in Salt Lake City, snow-dusted mountains loom large through the windows of Room 176 at Olympus High School. Inside the classroom, students in Stacy Firth's principles of engineering class are diving into a bioengineering design challenge. In teams of two or three, they must design and construct a prosthetic arm for an amputee in a developing country.

Firth, a U chemical engineering associate instructor, is leading a new high school program at Olympus High to introduce students to engineering. During the school year, sophomores, juniors and seniors in her class are introduced to various fields of engineering through hands-on projects to better understand the world of engineering.

"When I was in high school, I had no idea what engineers did. I was lucky to choose a field that I think is fantastic, and so I wanted to give students a chance to see what the possibilities are," says Firth, who earned her doctorate in chemical engineering at the University of Texas, Austin. "We designed this class as a survey, with the hope that students would take this class and start to learn to think like an engineer."

Through a partnership between the University of Utah College of Engineering and Granite School District, Firth and current and former teachers at Olympus High hammered out a plan of "what engineering should look like at the high school level," says Firth.

The program consists of the hands-on principles course being piloted this year and a parallel computer-modeling course to introduce students to engineering career choices, the basic mathematical concepts of engineering, and the engineering design process. Students develop their problem solving skills through challenges using basic engineering principles—and practical constraints.

"Before they started the challenge, we talked about how countries in developing nations don't have access to fancy parts or high-tech prostheses," says Firth. "So they must optimize for cost and use parts that are readily accessible. It sets the stage for some great out-of-box thinking from the students."

Despite having access to a state-of-the art industrial workshop, these students must innovate using everyday objects. Nails, rubber bands, dish sponges, soda bottles

and metal hooks are scattered on each team's worktable as possible parts of the prosthetic arm.

"I had no idea how many different areas of engineering there are," says Tyler McCuaig.

Bebe Germain says she was first inspired to learn more about engineering in the sixth grade.

"I got really interested in designing roller coasters so I wondered, 'what profession would this be?' The teachers told me it was mechanical engineering, so when I saw an engineering class was available here, I signed up," says Germain, a ninth-grade student who makes the trek from her junior high school to Olympus High each morning. "It's definitely been hard because I won't take chemistry or physics until next year, but if you are up for a challenge, it's worth it."

Milton Watts, a former engineer co-teaching the class with Firth, says the goal of the class is to give students "a big, broad spectrum of what engineering involves. Some may love one topic and hate another, but that's OK—there are many different kinds of engineering to get excited about."

To reach more students, Firth will spend part of her summer recording lessons from her class to be used in a flipped classroom format—by watching lessons before class, the time in the classroom can be used to tackle design challenges and other hands-on activities, says Firth.

As the bell rings signaling the end of the class period, students halt their lively discussion about the design process in a flurry of zippered backpacks.

"Back to the drawing board tomorrow," says a student holding a bicycle hook.

"This engineering class has been a way to introduce students to something that has such opportunity to affect the world in a positive way, as well as something I really love," says Firth. "If I can motivate a few students to take their math and science courses seriously, and explore beyond what they are normally exposed to, I would be so happy."

TRANSLATING TECHNOLOGIES

Six months after its launch, the University of Utah Center for Engineering Innovation (CEI) has generated $1.6 million in grants and nearly $400k in industry-based contracts.

Leveraging Utah Science Technology and Research (USTAR) Initiative investments, center staff members collaborate with university engineering and health sciences faculty to transform ideas into production-ready prototypes.

Housed within the College of Engineering and closely aligned with the Utah Nanofab, CEI staff guide clients through front-end activities, prototype creation and reliability testing.

Center director Florian Solzbacher, professor of electrical and computer engineering at the U, says CEI has already had a few repeat customers. This sustained business is in keeping with the center's business model of tackling small, focused projects that can be turned around within a matter of weeks, if not days.

"We now have a solid basis of work in electrodes, materials and chips, along with encapsulation and processing technologies that provide meaningful solutions for industry," says Solzbacher. "In addition, this work becomes a basis for larger opportunities down the road."

CEI staff member Loren Reith says the spectrum of customers they work with range from academic institutions, such as the U's Moran Eye Center, to companies small and large. USTAR faculty startup VaporSens is a client; as is Thermo Fisher, the largest supplier of disposable bioreactors in the country.

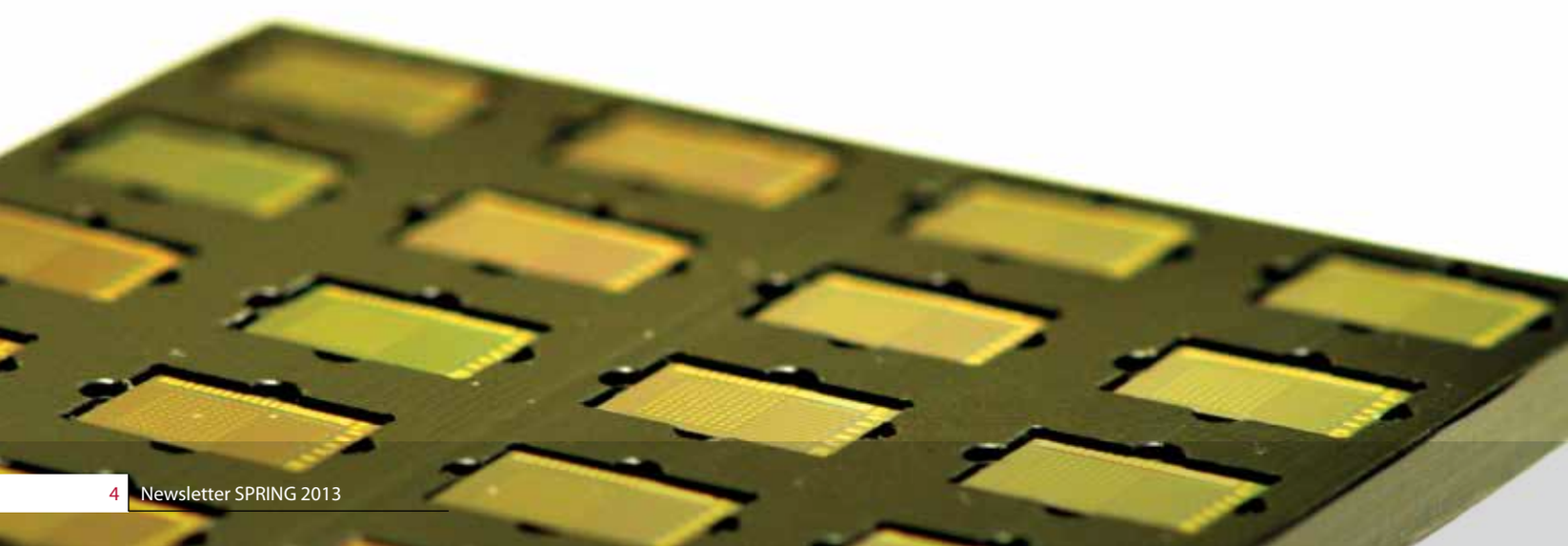
"Regardless of the company's size, we are able to turn around a quote quickly," said Reith, who is also a research assistant professor in electrical and computer engineering. "Even if there are intellectual property issues involved, the technology ventures and commercialization group here on campus can help us to start working within days."

Denton Vacuum, a family-owned company that makes sputter deposition systems, is working with CEI to test electrochromic materials.

"We have been very impressed with the quality of the research staff and facilities of the Center for Engineering Innovation," said Craig A. Outten, senior research scientist at Denton Vacuum in Moorestown, N.J. "This work has helped to accelerate the commercialization of our technology. The business practices of the University of Utah are a model for business-university interactions. Based on these initial results, we are planning a larger engagement with the university."

Solzbacher says it will be critical to continue growing the center by adding personnel, reinvesting in baseline technologies and bolstering industry involvement.

"Overall, the CEI is really successful," Solzbacher added. "Our challenges are that we need to bring more people on board and find some additional resources to stay responsive."



ALUMNI SPOTLIGHT: JASON JOB

The College of Engineering is pleased to recognize Jason Job (B.S. chemical engineering, 1997) for his support of the College and students. Job is president and CEO of Job Industrial Services, an industrial engineering and construction firm specializing in oil, gas, refining, mining and minerals.

During his senior year at the U, Job worked with U chemical engineering professor JoAnn Lighty on a program that gave students the chance to engineer and build a working project for the local children's museum.

"This opportunity was my first experience with project management—in our team of four, we had to come up with the project, define it, and then build it with a fixed budget of $5,000," says Job. "Halfway through, my team fizzled out. I like to finish things I start, so I took control of the project and saw it to completion on my own."

This tenacity helped launch Job's own engineering career, which started at CEntry Constructors and Engineers, along with a subsequent management position at Nalco Chemicals.

"Dr. Lighty saw my resolve and set up an initial interview with one of her mentors at CEntry, and I will forever be grateful for the doors she opened for me," says Job. "This was my first job as a process engineer. The skill sets I gained at the U helped me then, and they help me in my work now."

Job quickly realized that although he liked engineering, he was more interested in the "bigger picture." He soon became involved in engineering and construction management, drawing together and leading teams of engineers on larger-scale projects. By 2002, he was vice-president for business development at CEntry Constructors and Engineers.

In 2005, Job launched his own competing firm. "I've always been an entrepreneur, and the most important thing you have in this business is your own reputation," he notes. Through his hard work and the network of contacts he developed, Job Industrial Services has grown from twelve employees in 2005 to more than 60 today.

Job Industrial Services has clients all across the U.S., with a mix of large and small engineering and construction projects to keep workload steady, says Job.

"As an employer, I want to be surrounded by people with a strong work ethic who can collaborate with others," says Job. "I want people who aren't afraid to voice an opinion, who are respectful of others, and who don't give up."

Current U students, says Job, shouldn't focus entirely on grades. "It's more important to be honest at all times with yourself, understand concepts, be open to other people's ideas and accept constructive criticism. The real education starts when you get your first job."

IN BRIEF

FURSE NAMED EDUCATOR OF THE YEAR

Cynthia Furse, U professor of electrical and computer engineering, was recently named Educator of the Year by the Utah Engineers Council. The Council is an umbrella organization of 16 different local chapters and sections of engineering societies that aims to "advance the art and science of engineering and to provide a forum for communication between the varying engineering societies."

Furse was honored for her outstanding efforts at a banquet on February 22 featuring Adobe Systems co-founder and chairman of the board Dr. John Warnock, a notable U engineering alum.

"I've been teaching in Utah since 1994, and it's really satisfying," says Furse, who is also associate vice president for research at the U. "Engineering opens so many doors. I love running into my former students and hearing about the many exciting things they are doing in their careers and their lives."

SPIN-BASED POWER FOR DEVICES

Ashutosh Tiwari, associate professor of materials science and engineering at the U, led research in fabricating spintronics-based thin film devices that convert waste heat into useful electricity. Spintronics is a new branch of electronics that uses both the charge and spin of electrons. These new devices hold promise for efficient electronics that recycle their waste heat into electricity.

According to Tiwari, the severity of heat generation increases as electronics become nano-sized. Unlike previous devices, the new spintronic thermoelectric devices operate at room temperature without the continuous application of external magnetic fields to remain magnetized. This enables the device to achieve the heat-to-electricity efficiencies needed for practical applications.

The study was conducted with U engineering graduate students Gene Siegel, Megan Campbell Prestgard, and Shiang Teng. Funding was provided by the U.S. National Science Foundation's Condensed Matter Physics Program, Sensors and Sensing Systems Program, and the Utah Materials Research Science and Engineering Center.

SENSALE-RODRIGUEZ RECEIVES NSF CAREER AWARD

Berardi Sensale-Rodriguez, assistant professor of electrical and computer engineering at the U, has received the National Science Foundation's (NSF) prestigious Faculty Early Career Development (CAREER) award. The five-year, $400,000 award will support research and development of terahertz (THz) devices for low-cost communications. New THz-based solutions could permit larger bandwidths than the radio frequency and infrared wavelengths currently supporting wireless communication.

"The quest for ultra-high data rates is pushing the exploration of new technologies that can enable the use of currently unregulated higher spectral frequency bands such as the THz band," Sensale-Rodriguez says.

Beyond personal wireless communications, THz technology could spur advancement of medical devices such as THz-enabled skin cancer detection imaging systems. To make these devices cost-effective, his program will focus on employing thin-film semiconductors.

In addition to material and fabrication costs, the NSF CAREER Award will support graduate students studying THz technology and working with nanomaterials. Sensale-Rodriguez and his graduate students will also participate in educational technology outreach activities.

TINY PLASMA DEVICES RESIST RADIATION

U electrical engineers Massood Tabib-Azar and Pradeep Pai fabricated the smallest plasma transistors that can withstand high temperatures and ionizing radiation found in a nuclear reactor. Such transistors someday might enable smartphones that take and collect medical X-rays on a battlefield, and devices to measure air quality in real time.

"These plasma-based electronics can be used to control and guide robots to conduct tasks inside the nuclear reactor," says Tabib-Azar, U professor of electrical and computer engineering. "Microplasma transistors in a circuit can also control nuclear reactors if something goes wrong, and also could work in the event of nuclear attack."

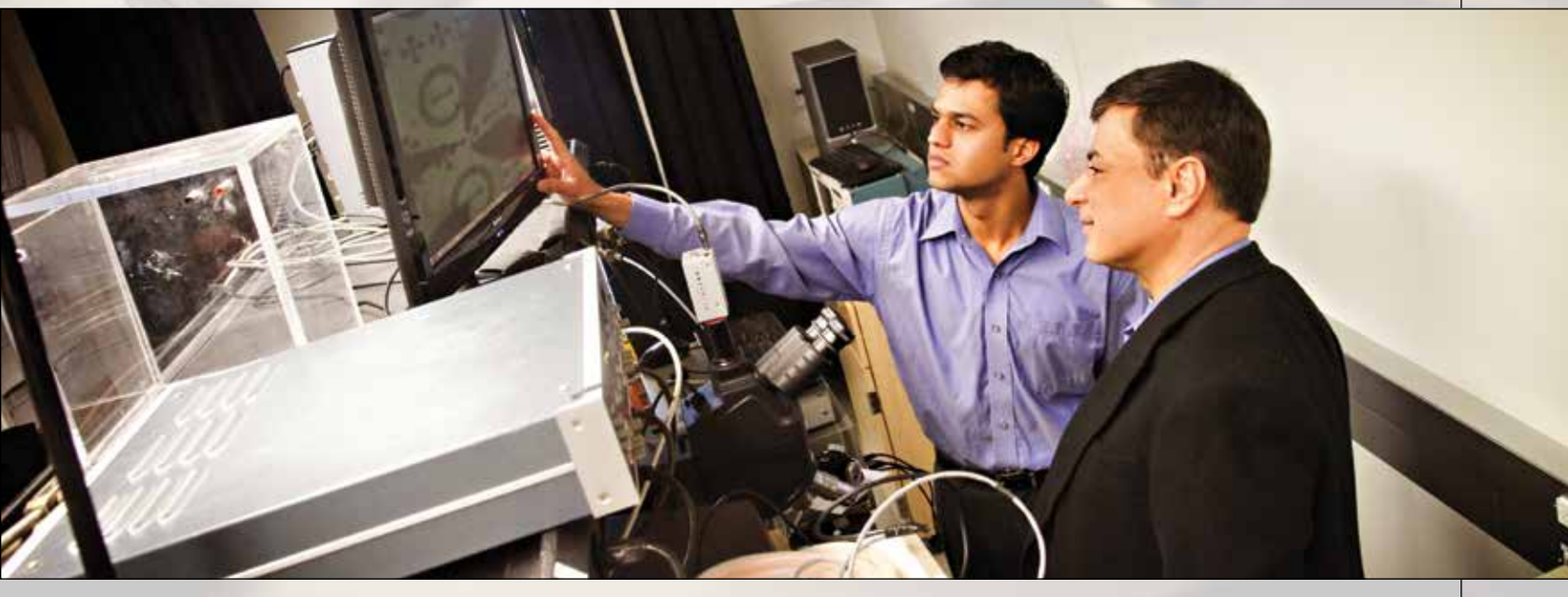
Transistors are the workhorses of the electronics industry. They control how electricity flows in devices and act as a switch or gate for electronic signals. Billions of transistors are typically fabricated as individual but connected components on a single computer chip. The most commonly used type of transistor is called a metal oxide semiconductor field effect transistor, or MOSFET.

Transistors control the flow of electrical charge through a silicon channel using an electric field to turn the transistor on or off, similar to a valve with the electric field as its control knob and electric charge as its current flow. Silicon-based transistors are a crucial component in modern electronics, but they fail above 550 degrees Fahrenheit – the temperature at which nuclear reactors typically operate.

Plasma-based transistors, which use charged gases or plasma to conduct electricity at extremely high temperatures, are employed currently in light sources, medical instruments and certain displays under direct sunlight (but not plasma TVs, which are different). These microscale devices are about 500 microns long, or roughly the width of five human hairs. They operate at more than 300 volts, requiring special high-voltage sources. Standard electrical outlets in the United States operate at 110 volts.

The new devices designed by the U engineers are the smallest microscale plasma transistors to date. They measure one micron to six microns in length, or as much as 500 times smaller than current state-of-the-art microplasma devices, and operate at one-sixth the voltage. They also can operate at temperatures up to 1,450 degrees Fahrenheit. Since nuclear radiation ionizes gases into plasma, this extreme environment makes it easier for plasma devices to operate.

"Plasmas are great for extreme environments because they are based on gases such as helium, argon and neon that can withstand high temperatures," says Tabib-Azar. "This transistor has the potential to start a new class of electronic devices that are happy to work in a nuclear environment."



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STUDENT LIFE

RESEARCH ROCK STAR

As a high school student, U chemical engineering senior Jamal Abdinor participated in an internship in the College of Engineering.

"Once I started the project, I fell in love with chemical engineering and wanted to continue in the field," said Abdinor, who will graduate from the U in May.

While still in high school, Abdinor was awarded the prestigious Gates Millennium Scholarship funded by the Bill and Melinda Gates Foundation. This award provides 1,000 talented U.S. high school students a "good-through-graduation" scholarship to use at any college or university of their choice.

Abdinor has worked with chemical engineering professor and chair Milind Deo and chemistry professor Michael Bartl to study the porosity of rocks in underground oil and gas reservoirs. Deo's group simulates flow in these reservoirs—not a simple feat given variations in rock porosity and shape.

By synthesizing mesoporous silicon dioxide particles in Bartl's laboratory, Abdinor creates ordered particles and studies their diffusion and permeability values to generate parameters that will be used in Deo's simulation.

"Jamal is very self-motivated—once the project and the problem were explained to him, he performed the necessary tasks to achieve his goals," said Deo.

Between classes and research, Abdinor also has engaged in the entrepreneurial spirit that sets the U apart from other universities. In 2012, he and a team of fellow engineers won the U's Bench to Bedside medical device competition.

Their device is an inhaler that improves delivery of medicine to the lungs of asthma patients. The team is reinvesting their $15,000 prize money into developing prototypes.

This fall, Abdinor will begin a doctoral program in chemical engineering at Columbia University. Although he will miss his family in Utah, Abdinor says he is excited by the prospect of living in New York City.

"I like doing research because it's so innovative," said Abdinor. "There's always something new and exciting going on. It's never boring."