UCSD Jacobs | School of Engineering

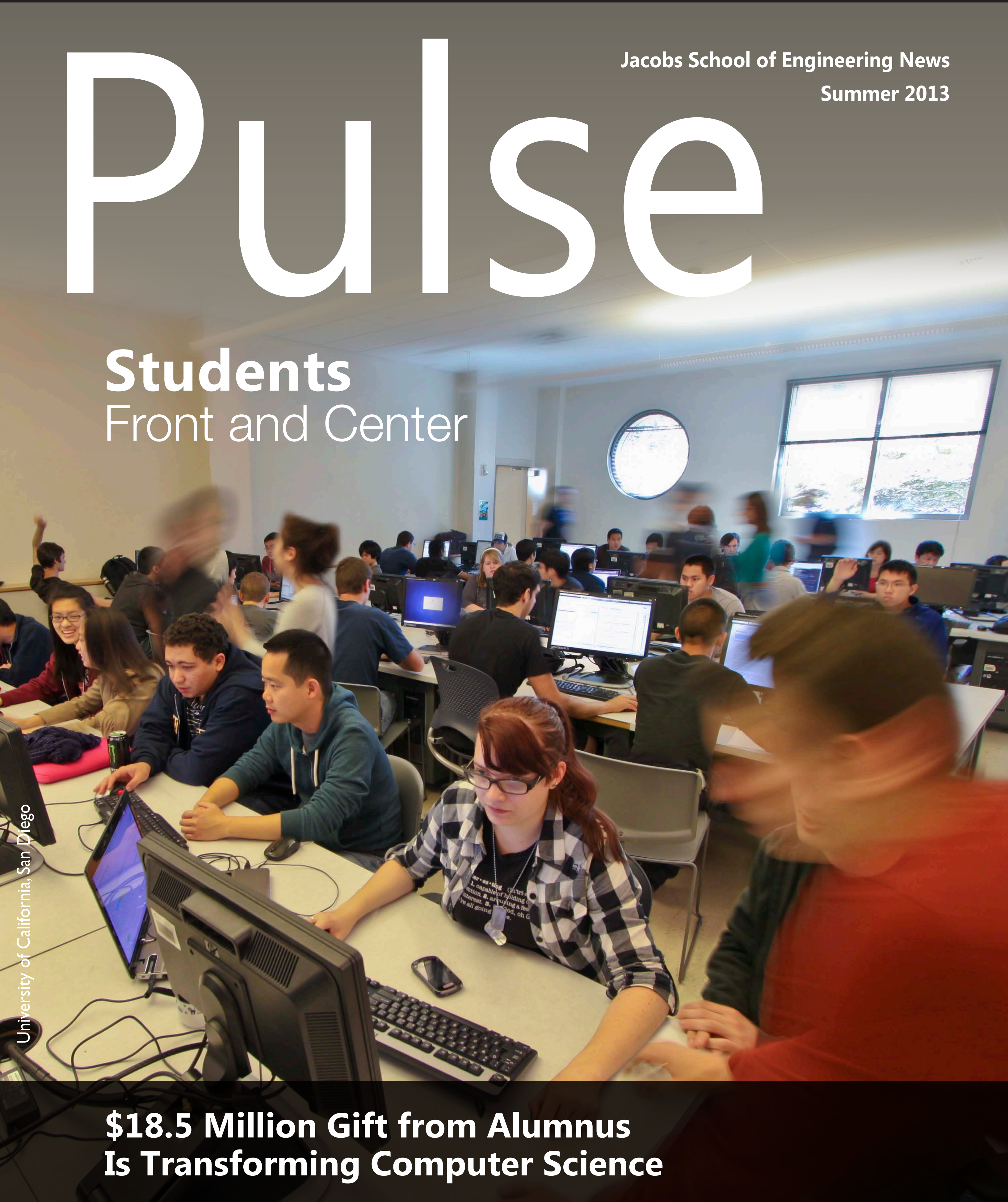
New Electron Beam Writer Up and Running

Calit2 at UC San Diego Named Qualcomm Institute

Pulse

Jacobs School of Engineering News

Summer 2013



Students
Front and Center

University of California, San Diego

$18.5 Million Gift from Alumnus Is Transforming Computer Science

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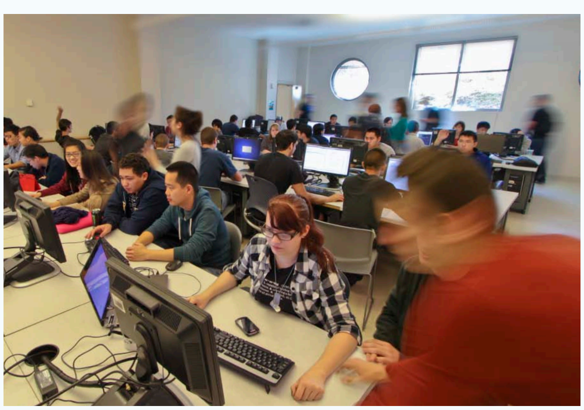


Cover shot: A busy undergraduate lab in the computer science department, whose motto is: Dig deeper. Be practical and practiced. And above all, be inspired.

Pulse Newsletter Team

Daniel Kane (editor)
Catherine Hockmuth, Josh Knoff, Ioana Patringenaru, Denine Hagen
Additional Photography: Erik Jepsen / UC San Diego Publications; Alex Matthews / Qualcomm Institute

To Reply to the Editor
dbkane@ucsd.edu, (858) 534-3262
9500 Gilman Drive, La Jolla, CA 92093-0403

Albert P. Pisano Named Dean of the Jacobs School of Engineering

Albert ("Al") P. Pisano, a mechanical engineer from UC Berkeley, begins his term as dean of the Jacobs School on Sept. 1, 2013.

Albert ("Al") P. Pisano begins his term as dean of the Jacobs School on Sept. 1, 2013.

"Al Pisano is one of those rare individuals who is an extremely accomplished engineering educator, researcher, organizational leader and entrepreneur," said UC San Diego Chancellor Pradeep K. Khosla.

A self-described "technology polyglot," Pisano's research is driven by his passion for developing, mastering and advancing technologies in order to solve problems. Pisano was elected to the National Academy of Engineering in 2001 for contributions to the design, fabrication, commercialization, and educational aspects of microelectromechanical systems (MEMS). Micrometer-scale machines with moving parts, MEMS play a central role in Pisano's current efforts to develop sensors that function in harsh and punishing environments such as within gas turbines, geothermal wells, jet engines and tires. One of his new MEMS projects is development of an inexpensive yet rugged sensor system that will predict landslides in the Philippines. Pisano is also developing larger sensors that can be manufactured at extremely low cost and made from sustainably sourced polymers.

Undergraduate engineering education is another of Pisano's passions. Last year, he developed and taught a rapid prototyping class for engineering freshman at UC Berkeley, which gave students hands-on experience at the very start of their college careers.

"We had students building car chassis, truss elements for load and deflection analyses, and viscometers for measuring the viscosity of fluids—all as freshman before they had the prerequisite classes," said Pisano. "Early on as undergraduates, engineering students should have the opportunity to feel what it's like to be an engineer. I look forward to working with the faculty and staff of the Jacobs School to strengthen our undergraduates' hands-on and practical engineering experiences."

At UC Berkeley, Pisano held the FANUC Endowed Chair of Mechanical Systems as well as faculty appointments in both the mechanical engineering department and the electrical engineering and computer sciences department.

Over the 30 years he spent as a professor UC Berkeley, Pisano served as a leader at the department, school and campus level. Positions included chair of the mechanical engineering department; acting dean of UC Berkeley's engineering school; the Founding Faculty Head of the Operational Excellence program office; senior co-Director of the Berkeley Sensor & Actuator Center (an NSF Industry-University Cooperative Research Center); and Director of the Electronics Research Laboratory (UC Berkeley's largest organized research unit). Pisano also served as a program manager for the Defense Advanced Research Projects Agency (DARPA).

Pisano earned his undergraduate ('76) and graduate degrees ('77, '80, '81) in mechanical engineering at Columbia University.

$18.5 Million Gift from Alumnus
Transforming Computer Science

A UC San Diego alumnus recently made an $18.5 million gift to the Computer Science and Engineering Department at the Jacobs School. This gift will enable computer science to reach unprecedented levels of excellence, with a particular focus on students, through new initiatives and projects that would not otherwise be possible (see pg. 5 for details). This is the largest gift ever made to UC San Diego by one of its alumni. It comes at a time of tremendous growth in undergraduate enrollments in computer science. With a projected 1,800 undergraduate students in fall 2013, it is one of the largest computer science departments in the nation.

The gift provides permanent resources that will help these students become industry leaders at a time when computer scientists play crucial roles in nearly every field. Computer scientists interface with an increasing number of mission-critical systems and address society's pressing problems—ranging from energy and environmental sustainability, to security, democracy and healthcare. They work as software and systems engineers; application developers; network gurus; database designers; experts in data centers, cloud computing, systems security; and much more.

"This gift comes at a critical juncture as we position the department for tremendous growth in its rankings and reputation. It will enable us to significantly enhance the quality of our instructional mission by putting our students at the front and center of all our activities."

Rajesh Gupta
Professor and Chair
Department of Computer Science and Engineering

Inspiring Imaginations Initiative

This $18.5 million gift from the anonymous computer science alumnus puts the Computer Science and Engineering Department (CSE) more than halfway to its $25 million Inspiring Imaginations fundraising goal. Inspiring Imaginations is a three-year initiative focused on strengthening undergraduate computer science education at the Jacobs School. Driven in large part by the explosive growth in undergraduate enrollment, the initiative is designed to improve the undergraduate experience via infrastructure improvements and permanent increases in funding—through endowments—for student support, faculty and new programs. Elements of the initiative are listed below.

Tutors, Tech Staff and TAs

Many more tutors (see pg. 7), technical support staff and teaching assistants will interact with computer science undergraduates thanks to the new gift. The ultimate goal is to provide one tutor for every six undergraduate students in key introductory classes.

More Labs

The gift provides just over half of the estimated $5.5 million needed to create the Design Innovation Center within the Computer Science and Engineering building. The remodel and expansion will add 7,000 square feet in teaching laboratories, and better integrate the undergraduate labs on the lower level with the CSE research enterprise (see pg. 6).

New Classes

Advanced undergraduate courses will be created that follow introductory courses in many areas, including networking, distributed computing and embedded and mobile computing systems.

Better Equipment

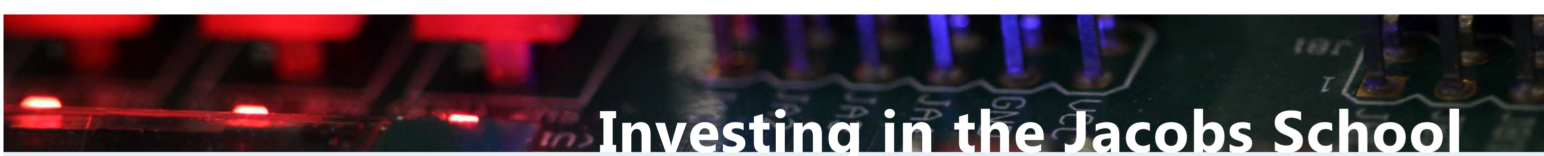
Better equipment is on the way such as state-of-the-art hardware and software to model computer architecture. There will be new equipment to build prototypes of new computers using design and prototyping tools, including 3D printers. There will be facilities for in-house printed circuit board design and FPGA assembly—as well as technical staff to run labs and mentor students.

Endowed Chairs

Five new endowed chairs will enable UC San Diego to attract the highest caliber computer science professors in growth areas such as big data, computer systems and cyber-physical systems. Three of the chairs are specifically marked for attracting topmost junior faculty to the department.

> "This gift is not about me. It is about the computer science and engineering department—and most importantly, the students. I made this gift to recognize the wonderful education I received and to assist the department in its efforts to reach even higher levels of excellence."
>
> – **Anonymous computer science alumnus**
> This individual made the $18.5 million lead gift for the Inspiring Imaginations Initiative.

Inspired? Learn more.
http://CSE.ucsd.edu/InspiringImaginations



Investing in the Jacobs School

You can specify how gifts to the Jacobs School will benefit students, faculty, programs or departments. There are many ways to maximize your gift's impact, make your giving experience meaningful and enjoyable, and realize tax benefits.

If you would like to explore giving options such as stock transfers, multi-year pledges, or including the Jacobs School in your estate plans, please contact Lisa M. French at (858) 246-0593 or lfrench@ucsd.edu.

DESIGN INNOVATION CENTER

The computer science department is creating a Design Innovation Center—the centerpiece of the renovation and expansion of the computer science building. The Center will provide workspace and equipment for student-faculty interaction as well as team engineering projects ranging from embedded computing and robotics to visualization, graphics and human-computer interaction.

"The Design Innovation Center will encourage our undergraduates to be a part of our world-class research infrastructure. We are creating a space for interaction for the coming generations of computer scientists who will go out and change society," said Rajesh Gupta, professor and chair of the computer science department.

The remodel and expansion also includes a project that will literally shine light on the undergraduates thanks to an open staircase connecting the undergrad computer science labs in the basement to the first floor.

The Design Innovation Center is designed to help students and faculty live up to the department motto to "Dig deeper. Be practical and practiced. And above all, be inspired."

These words are particularly fitting in today's computing environment, where computer science students need to know more than programming by graduation. They need hands-on experiences working on software and hardware platforms. They need to be able to prototype, experiment and create.

Inspiration for the Center comes from many places including the Jacobs School's Moxie Center (see pg. 14) which helps students turn their ideas into companies; and CSE's Embedded Systems Laboratory, a space that allows students to program on hardware platforms provided by the department's industry partners. The center will integrate engineering design at the undergraduate level with the computer science research enterprise, described in the section below.

The computer science building with new entrance (red façade) leading to the Design Innovation Center and the open staircase to the basement labs.

Barely 25 Years Old, the Computer Science and Engineering Department Is Driven by Young and Forward-thinking Faculty.

Computer science faculty and students study and work within a rich ecosystem of academic centers and research institutes at UC San Diego including:

- The Center for Magnetic Recording Research (CMRR)
- The Center for Networked Systems (CNS)
- The Center for Wireless Communications (CWC)
- The Qualcomm Institute—the UC San Diego division of Calit2
- The San Diego Supercomputer Center (SDSC)

The computer science department is deeply rooted within research, innovation and industry networks across campus, on the Torrey Pines Mesa, and in San Diego, California and beyond. **http://www.CSE.ucsd.edu/**

Computer science research strengths include:

- machine learning
- databases
- graphics and vision
- systems and networking
- security and cryptography
- software engineering
- bioinformatics
- computer architecture
- embedded systems
- theoretical computer science

According to a recent Microsoft Academic Search ranking, computer science at UC San Diego is ranked:

6 overall among U.S. universities
4 in bioinformatics
5 for systems
7 for network & communication

Computer science brochure (PDF): **http://bit.ly/17niTDn**

Computer Science Tutor Reunion

“To me, it’s not a tutor reunion, it’s a family reunion.”

That’s how Anu Mupparthi (BS ‘08, MS ‘11) described her experience at the recent computer science tutor reunion June 7 on campus. “I come back to the people who made me who I am,” said Mupparthi, who now works in the Google+ photo group. She is one of the 170 alumni of the tutor program who came back to UC San Diego for their second-ever reunion.

“Any engineer can write code,” said Stuart Moskovics, also a former tutor (BS ‘96, MS ‘00). The difference between a regular engineer and a great engineer is the ability to teach what they know, and that’s one of the skills tutors gain, explained Moskovics, now a Qualcomm employee.

Tutors are stationed in undergraduate labs, where they provide one-on-one and small-group mentoring. Students in introductory classes get help at crucial moments; tutors develop marketable leadership and teaching skills; and the entire department benefits from a stronger sense of community. Tutors work for Susan Marx, Rick Ord and Gary Gillespie (The latter two are CSE alumni and served as tutors themselves.)

“You go out into the world and you realize how much further along you are than other people,” said Chad Martin (BS ’08), who tutored for Gillespie. “I’ve been working for a while, and I really appreciate my education.”

The current students who presented their video game demos for CSE 125 just prior to the reunion impressed Taurin Tan-atichat (BS ’06, MS ‘08). A member of the Jacobs School Alumni Council, Tan-atichat thinks an even better generation of computer science graduates is on the way.

Rick Ord and Gary Gillespie inspired Ojas Sitapara (BS ‘04), now at Intuit, to come to the reunion. “Gary and Rick create an environment amongst tutors in their classes that made you feel connected to other students.”

“This really is a family,” said Ord, who recounted the story of an exam he gave on a finals-week Friday from 7 to 10 p.m. Instead of grading alone all night, as he imagined, tutors showed up at Round Table to help. Ord and his tutors did the grading as a team.

As part of the Inspiring Imaginations initiative, the computer science department created the CSE Tutor Challenge with the hope of raising $250,000 for the tutor program. The department will match all gifts for the tutor program 1:1 up to a total of $125,000. Many former tutors have already stepped up, including Taner Halicioglu (BS ‘96) who recently made a $25,000 gift to the program.

Take the challenge, and make a gift online at: http://bit.ly/17gFaTo

(L–R) Kylie Taitano, Eliah Overbey, Anu Mupparthi (BS ‘08, MS ‘11) and Gabriela Ponce. See more photos at: http://bit.ly/18tQ2Nj

New Electron Beam Writer Enables Next-Gen Biomedical and Information Technologies

Ryan Anderson, a process engineer for the Nano3 facility in the Qualcomm Institute, prepares to remove a sample from the Vistec EBPG5200 electron beam writer.

The new electron beam writer housed in the Nano3 cleanroom facility at the Qualcomm Institute is important for electrical engineering professor Shadi Dayeh's two major areas of research. He is developing next-generation, nanoscale transistors for integrated electronics; and he is developing neural probes that have the capacity to extract electrical signals from individual brain cells and transmit the information to a prosthetic device or computer. Achieving this level of signal extraction or manipulation requires tiny sensors spaced very closely together for the highest resolution and signal acquisition. Enter the new electron beam writer.

Electron beam (e-beam) lithography enables researchers to write very small patterns on large substrates with a high level of precision. It is a widely used tool in information technology and life science. Applications range from writing patterns on silicon and compound semiconductor chips for electronic device and materials research to genome sequencing platforms. But the ability to write patterns on the scale afforded by the Nano3 facility—with its minimum feature size of less than 8 nanometers on wafers with diameters that can be as large as 8 inches—is unique in Southern California. Before the facility opened earlier this year, the closest comparable e-beam writer was in Los Angeles. (See pg. 9 for information on using the new facility.) In an e-beam writer, unique patterns are "written" on a silicon wafer coated with a polymer resist layer that is sensitive to electron irradiation. The machine directs a narrowly focused electron beam onto the surface marking the pattern, making parts of the resist coating insoluble and others soluble. The soluble area is later washed away, revealing the pattern which can have sub-10 nanometer feature dimensions.

Bioengineering professor Todd Coleman will use the new e-beam writer as one essential step in the building of his epidermal, or tattoo, electronic devices. The devices are designed to acquire brain signals for a variety of medical applications, from monitoring infants for seizures in neonatal intensive care to studying the cognitive impairment associated with Alzheimer's disease or dementia, and soldiers struggling with post-traumatic stress syndrome (see pg. 13).

Electrical engineering Ph.D. candidate Andrew Grieco, from Shaya Fainman's lab, is using the machine to develop a new type of optical waveguide that promises to improve efficiency and reduce power consumption. Developing on-chip optical networking devices such as waveguides, switches and amplifiers is a critical step in the development of optical chips. Although information systems rely primarily on fiber-optic networks to connect and share data around the world, the underlying computer technology is still based on electronic chips, causing data traffic jams.

"Any local company that has an investment in nanoscale science and technology should greatly benefit from this machine. It's a powerful tool that is hard to find in a typical university setting or within local industry," said Dayeh (Ph.D., 2008 UC San Diego), who joined the faculty in 2012. "It's a unique tool that is being brought to San Diego. "

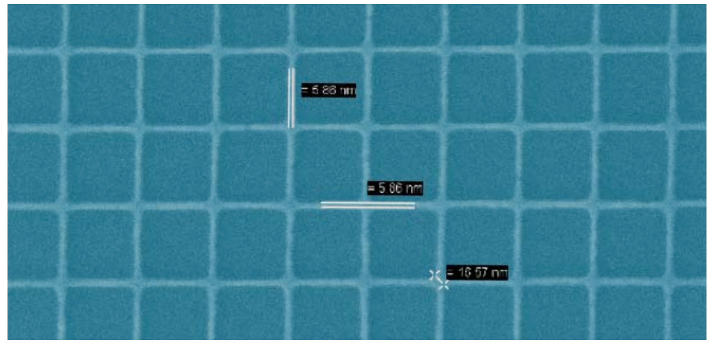
Dayeh said technologies enabled by the e-beam writer will be important in local efforts to conduct research under President Obama's BRAIN Initiative, which will require developing much smaller sensing and stimulating elements with higher resolution on chips the size of a few millimeters. "Current state-of-the-art electro-neural interfacing technology enables sensing from hundreds or thousands of neurons. If you want to understand the neurophysiology on the individual cell basis then we need to develop sensors that have the spacing of a few tens of nanometers, which is about one-hundredth the size of a neuron and is on the same scale as their synaptic connections," he said.

Electron Beam Facility Is Open for Business

UC San Diego's new Vistec Lithography EBPG5200 electron beam writer is available for use by campus researchers, as well as industry and research partners. The e-beam writer, used for nano and micro-fabrication (see pg. 8), is a new addition to the Qualcomm Institute's Nano3 facility, which provides a synergistic environment for fundamental research and development efforts at the nanoscale with a focus on nanoscience, nanoengineering and nanomedicine. In addition to providing essential nanofabrication capabilities for research on electronic and photonic materials and devices, Nano3 facilitates the pursuit of research in emerging, interdisciplinary and rapidly growing fields such as biomedical and biochemical devices, monolithic and heterogeneous integrated electronic and photonic devices and circuits, and sensor technology.

The new e-beam writer enables researchers to write fine features on a scale of less than 8 nanometers, over a large surface area up to 8 inches. The challenge of writing over large fields with electron beams is that the beam of electrons can become larger and diffused, distorting the features of the pattern. However, the EBPG5200 has superior electromagnetic focusing capability for extremely narrow electron beams over 1x1 mm^2 write fields and a high stitching accuracy, which allows ultrascaled features to be written not only on research scale samples but also on commercial and production size wafers.

Adding the Vistec e-beam writer to Nano3 was enabled by funding from the Major Research Instrumentation program of the National Science Foundation, with contributions from UC San Diego, the Jacobs School of Engineering, the Department of Electrical and Computer Engineering, the UC San Diego School of Medicine, and Qualcomm Institute / Nano3.



Colorized micrograph of an electron beam-written grid pattern demonstrating < 8 nm resolution capabilities of the EBPG5200.

Vistec Lithography EBPG5200 specifications include:

- High-resolution gaussian beam system
- Thermal field emission source with 50/100 kV beam energy
- Minimum feature size < 8 nm
- Write field size up to 1mm; stitching < 30 nm (mean + 3σ)
- Sample holders: 2", 3", 4", 8" wafers and pieces, 6" mask
- 50 MHz pattern generator
- Z Lift (adjustable stage height) option

Details and Availability:
Dr. Maribel Montero (858) 534-4222
Ryan Anderson (858) 822-5663
nano3ebeam@calit2.net
http://nano3.calit2.net/

UC San Diego Division of Calit2 Named Qualcomm Institute

Qualcomm Chairman & CEO Dr. Paul E. Jacobs at the Qualcomm Institute open house on May 24.

QUALCOMM INSTITUTE

Calit2

UC San Diego named its division of the California Institute for Telecommunications and Information Technology (Calit2) in honor of the philanthropy of the San Diego-based wireless technology leader, Qualcomm Incorporated. The multidisciplinary research center is now known as the Qualcomm Institute for Telecommunications and Information Technology, the UC San Diego Division of Calit2; or Qualcomm Institute for short. The name change recognizes the critical role Qualcomm, and more recently, its affiliated Qualcomm Foundation, have played in Calit2 since the state of California created it in 2000. Gifts to Calit2, including recent grants from the Qualcomm Foundation, have pushed Qualcomm's philanthropic support for the institute to just under $26 million.

"This recognition is much deserved given the important roles that Qualcomm and the Qualcomm Foundation have played in helping us to build and cement the Institute's reputation as a world leader in technologies that benefit society," said UC San Diego Chancellor Pradeep K. Khosla.

First NanoEngineering Degrees Awarded to UC San Diego Undergrads

April Pereira, (left) one of the first UC San Diego students to earn an undergraduate degree in nanoengineering, at work in a senior design lab. Pereira is a Marine Corps veteran twice deployed to Iraq.

Stripped down to the most basic process, nanoengineering "is the manipulation of molecules and atoms in order to construct things from the bottom up," said Cody Carpenter, a member of the first class of Jacobs School undergraduates to earn a degree in NanoEngineering.

Carpenter called nanoengineering "the second industrial revolution" and it's clear that he and his fellow graduates feel they are embarking on an open-ended professional journey that is simultaneously pioneering and immensely practical. Nanoengineering is being applied to most industries from energy to medicine to computer science, which is why the nanoengineering curriculum gives undergraduates a strong foundation in physics, chemistry and biology. Students are also required to select a focus area in materials science, electrical engineering, mechanical engineering, bioengineering or chemical engineering.

Beautiful. Creative. Cutting-edge. Challenging. Open-ended. Hands-on.

...and most frequently, experimental. These are the words the first crop of nanoengineering undergraduates use to describe the program they helped to create simply by being among the first to do it. And, bolstered by the act of achieving a degree in such an interdisciplinary field, they feel confident about their unique skill sets and academic experiences.

"Once you understand that all fabrication-based companies are using nanoengineering, it's all about making that connection between what they already know and what you're doing in the lab," said Yahya Alvi, who will spend the summer interning at Intel before returning this fall to earn his master's in nanoengineering. Eventually, Alvi plans to also earn an MBA and enter industry. He is interested in developing new medical diagnostics based on nanotechnology.

Like Carpenter and most undergraduates in nanoengineering, Alvi has been actively engaged in research. He worked in the laboratory of professor Andrea Tao where he learned to control the size and shape of silver and gold nanoparticles and mold them into cubes, triangles, pyramids and octahedrons.

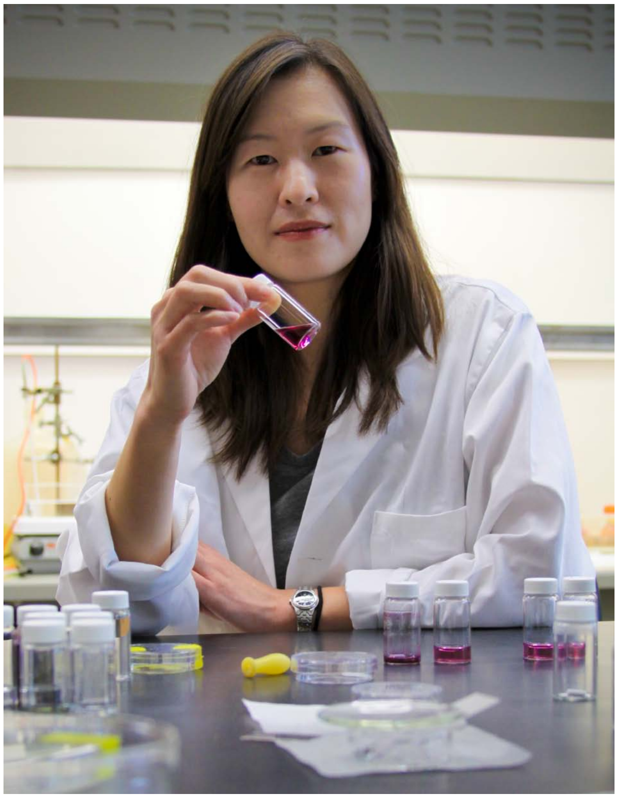
Professor Donald Sirbuly, who along with Tao teaches the two-quarter senior design lab known as Nano 120, said learning about the complexity and sensitivity of processes occurring at the interface of materials is fundamental for students in nanoengineering and gives them a unique mindset as problem solvers. "They get a really good feel for how to work with the materials," said Sirbuly. "It's not enough to just know conceptually what's going on. We give them real, open-ended problems."

The senior design lab culminates in students designing a device that solves a problem in a field of their choice, generally selected from problems faculty researchers are experiencing. Going forward, Sirbuly would like to work even more closely with industry partners in order to challenge undergraduate researchers with problems currently facing the industrial sector.

"We encourage our students to think bigger than their coursework. How could you make an impact? There are bottlenecks in almost every technology," said Sirbuly. "The point of nanoengineering is to build the next-generation engineer. I think they're going to have a very broad skill set."

UC San Diego began offering nanoengineering as an undergraduate degree program in fall 2010. Since then, undergraduate enrollment has grown from 51 students to 273, and is expected to reach nearly 400 students this fall.

Q&A with Andrea Tao, NanoEngineering Professor



Andrea Tao joined the NanoEngineering faculty at the Jacobs School in 2009. She earned a Ph.D. in chemistry from UC Berkeley.

We sat down with professor Andrea Tao to discuss nanoengineering education, research and jobs. Tao's research is focused on fabricating functional nanostructure materials. Most recently, her research group developed a technique that enables metallic nanocrystals to self-assemble into larger, complex films and arrays for next-generation antennas and lenses. Much of Tao's work involves making materials using wet chemistry—which is a powerful approach because it provides fine-grained control when designing a material from scratch.

The Jacobs School conferred its first crop of undergraduate degrees in nanoengineering this June. NanoEngineering, the first department of its kind, was established in 2007 and offers undergraduate and graduate degrees in nanoengineering and chemical engineering. The department plans to introduce a new undergraduate materials engineering degree in 2014.

How would you describe the NanoEngineering curriculum?

We teach core classes such as chemistry, biology and physics from a nanomaterials perspective. For example, I teach a class on the chemical principles of nanoengineering in which we look at things such as how the atoms in carbon nanotubes or graphene bond together to form their special nanoscale structures. Students need to understand how the properties of a nanotube or sheet of graphene come from atomic-scale bonding. Our students spend a lot of time studying the properties of nanomaterials and how to interface materials at the nanoscale. Our curriculum is designed so that students will have a very good understanding—both from classical study and hands-on lab research—of how to control and tune those properties to change the material. In our senior design lab, students have to synthesize nanoscale particles, wires and films and incorporate them into a device. They also learn how hard it is to work with nanomaterials. You really have to understand how chemical processes behave on the nanoscale in order to change them.

Chemical engineering is part of the NanoEngineering Department. What kinds of synergies do you see between the two disciplines?

Chemical engineering involves getting processes to work over large macroscopic scales—the scale of industrial-level manufacturing. It's figuring out how to take a vat of this chemical and mix it with a vat of that chemical. What are the processes that control how I'm going to manipulate chemical reactions at realistic industrial scales? As nanoengineers, we will eventually be interested in how to manufacture nanomaterials on industrial scales, so there's a lot of synergy between the two. But before we get to that point, nanoengineers work as materials scientists at the atomic level in order to manipulate a given nanomaterial or nanoscale process.

What careers are NanoEngineering students prepared for?

Many companies have products based on nanomaterial technologies. Screens on Kindles, iPhones and other devices operate using nanoparticles and electronic inks. Nanoengineering has applications in every field including medicine and energy production. Even some amber and green beer bottles keep carbon dioxide from leeching out thanks to nanotechnology and materials. It's an enabling technology that allows us to make better materials for pretty much anything. I think our nanoengineering students will be highly creative in the workplace or research lab, in part because we've created an interdisciplinary curriculum including hands-on work rooted in faculty research. Our students are also highly competitive for a variety of master's programs that often lead to industry jobs. They receive a solid foundation in all the core sciences and have extensive experience manipulating materials on the nanoscale. Many companies may not even realize they need employees who are trained in nanoengineering, but you'll see these skill sets in job descriptions if not in the actual job titles. It's just that companies often don't use the term "nanoengineering." But that is starting to change. I don't think we're too far off from having a job listing that says "looking for a nanoengineer."

Background image: Nanosponges invented in the lab of prof. Liangfang Zhang may one day soak up toxins from your bloodstream. Nanoengineering undergraduates, including Cody Carpenter, work in the Zhang lab. More at: **http://bit.ly/16eRW0f**

Currents, Waves and Hawaiian Reefs

A team of researchers will install instruments off the leeward side of Oahu this summer to collect data that will help engineers improve computerized models that simulate how currents and waves behave when they encounter coral reefs. One application of the work will be to help model how storm waves flood tropical coastlines.

One of the researchers leading the effort is Geno Pawlak, a professor of mechanical and aerospace engineering here at the Jacobs School. Before coming to UC San Diego in 2012, Pawlak was a professor at the University of Hawaii. He has continued to work closely with his former colleagues.

"The applications of our research are broad, since the turbulence associated with drag on the ocean's bed affects how pollutants, nutrients and larvae disperse, as well as temperature," Pawlak said. "From a basic research perspective, we're trying to pin down how much energy is lost by currents and waves over rough surfaces like coral reefs. This energy loss turns out to be an important unknown in developing numerical models for currents and waves, particularly for complex environments like coral reefs."

Divers will deploy instruments on weighted frames on the ocean floor, similar to the three acoustic Doppler velocimeters pictured here, which measure water velocity and pressure. Other instruments will be attached to lines anchored to the ocean bed on one end and to a buoy that floats close to the surface of the water on the other. Researchers also will use an autonomous underwater vehicle from the University of Hawaii to map the ocean's bed and measure water properties, such as temperature. The work is partially funded by the Office of Naval Research and by the U.S. Army Corps of Engineers.

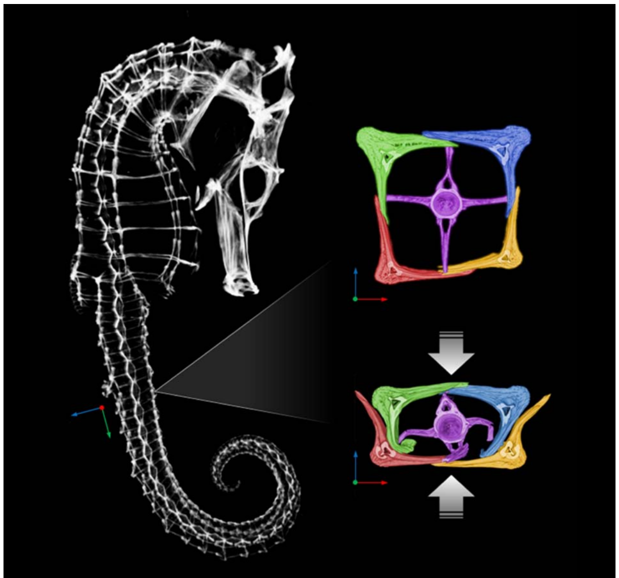
Seahorse to Robot

Materials scientists at the Jacobs School are developing a 3D-printed robotic arm inspired by the seahorse's tail. They chose the seahorse for its exceptional flexibility—the animal's tail can be compressed to about half its size before permanent damage occurs. That flexibility is due to the tail's structure, made up of bony, armored plates, which slide past each other.

"The study of natural materials can lead to the creation of new and unique materials and structures inspired by nature that are stronger, tougher, lighter and more flexible," said Joanna McKittrick, a professor of materials science and mechanical engineering who led the effort with graduate student Michael Porter.

Scan for video

The robotic arm would be equipped with muscles made out of polymer and could be used in medical devices, underwater exploration and unmanned bomb detection and detonation. The story attracted the attention of many media outlets, including ABC News, Reuters and Scientific American. Seahorse video and interviews at **bit.ly/11bhc70**



Seahorse tails compress to half their original size before permanent damage occurs.

Nanofoams for Better Body Armor, Layers of Protection for Buildings

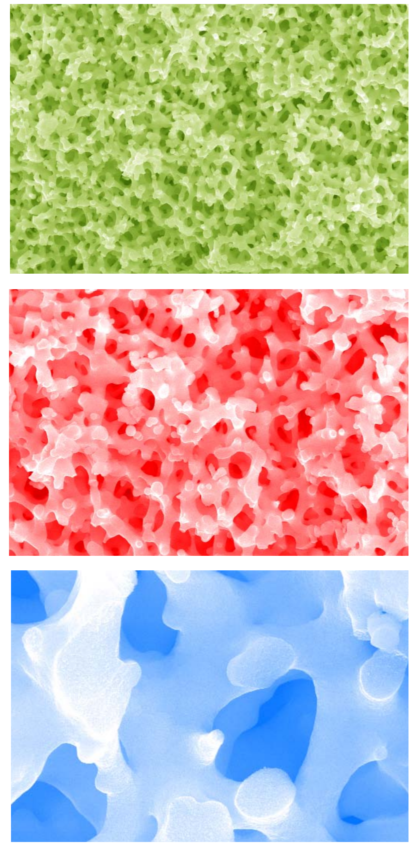
Porous nanofoams might be the future of body armor and blast protection, say engineers at the Jacobs School. They are developing a new material that could be used to make better body armor; prevent traumatic brain injury and blast-related lung injuries in soldiers; and protect buildings from impacts and blasts. It's the first time researchers are investigating the use of nanofoams for structural protection.

"We are developing nanofoams that help disperse the force of an impact over a wider area," said Yu Qiao, a structural engineering professor. "They will appear to be less rigid but will actually be more resistant than ordinary foams."

Researchers are in the first year of a three-year program funded by the Army Research Office. "We are getting some promising results," Qiao said.

The nanofoams are like honeycombs. They are porous and light—pores make up anywhere from 50 to 80 percent of the structure. Researchers have been trying to determine the optimal pore size to absorb energy from impacts. They have manufactured samples with pore sizes ranging from 10 nanometers to 10 microns. Preliminary results show that when pore size reaches tens of nanometers, the material seems to perform best. Those samples absorb energy from an impact or blast over a wider area, which makes the material more resistant to impacts and blasts. By contrast, in ordinary foams, energy is absorbed in one localized area, leading to quick failure. This problem, called damage localization, means that ordinary foams do not perform well as protection against impacts or blasts.

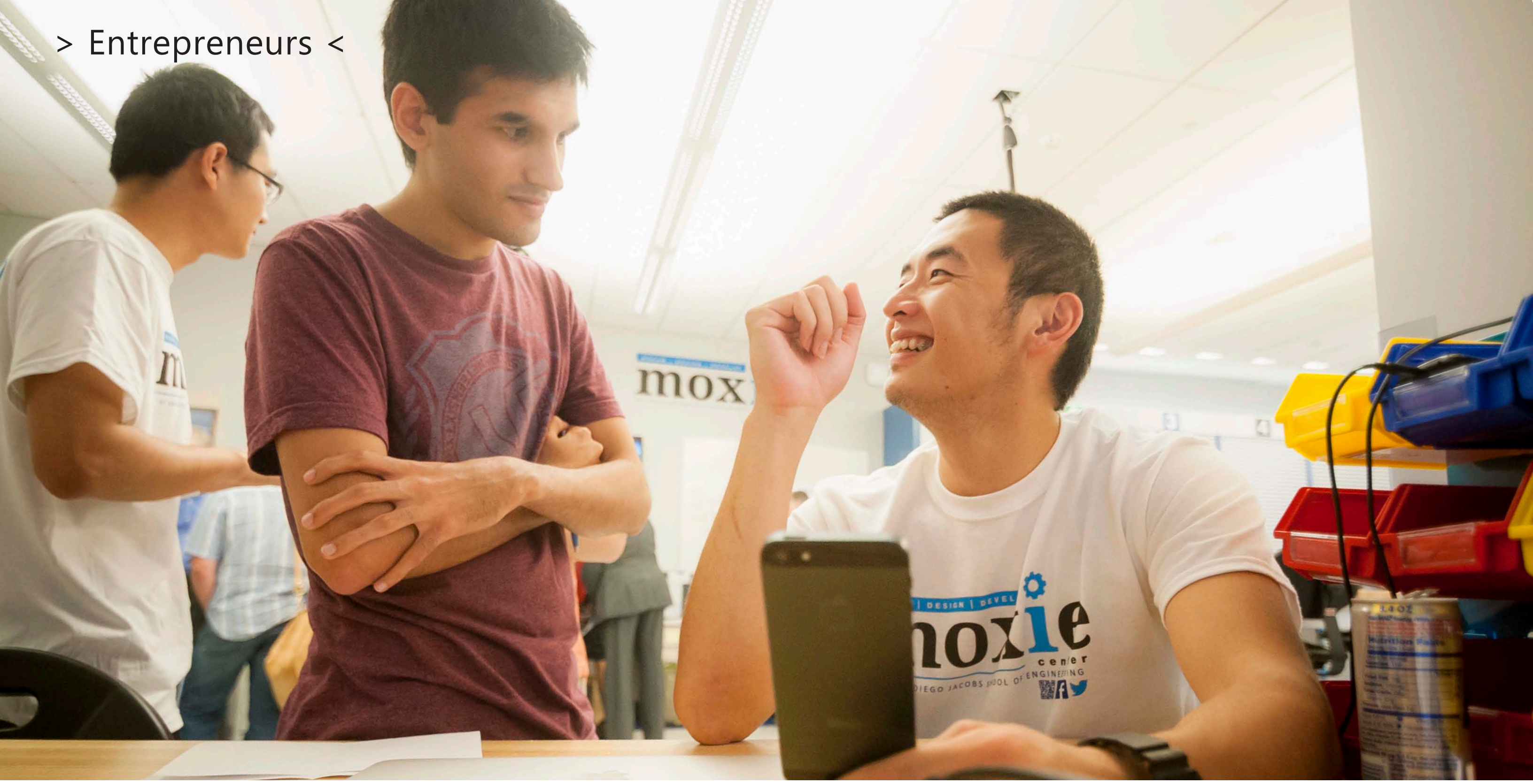
"People have been looking at preventing damage from impacts for more than a hundred years," said Qiao. "I hope this concept can provide a new solution."



Nanofoams made from porous silica, with an average pore size of a few microns, seen at the 50-micron, 20-micron and 5-micron scale. Engineers are developing nanofoams that disperse the force of an impact over a wider area than conventional foams.

Wearable Sensors Help Bioengineers Understand Infant Brain Development

Neonatal intensive care has brought amazing advances in the survival of critically ill newborns, particularly in the area of stabilizing babies with heart and lung problems. Now, experts are focused on continuous monitoring in order to treat brain injuries as they occur, to reduce the prevalence of cognitive and motor development issues that result from seizures, ischemia and brain hemorrhage. Currently, newborns in intensive care are wired up with electrodes designed to monitor vital signals such as heart rate, respiration and electrical rhythms of the brain. A new study of patients in neonatal intensive care at two San Diego hospitals led by bioengineering professor Todd Coleman and Dr. Mary J. Harbert is testing whether all of those bulky electronics that can damage or cause inflammation could be replaced with a stamp-sized wearable patch. Comprised of tiny circuits, sensors, and wireless transmitters, the patch sticks to the skin like a temporary tattoo, stretching and flexing with the skin while maintaining high performance. By combining simultaneous, real-time measurements of multiple vital signs with Coleman's unique expertise in signal processing and quantitative neuroscience, the research promises to open up a new frontier in doctors' understanding of the developing newborn brain. For example, new insights into brain development such as the relationship between certain brain injuries and developmental disorders. Future sensors will be built with the help of UC San Diego's new e-beam writer (see pg. 8).



Moxie Center for Undergraduate Entrepreneurship Strengthens the Engineering Talent Pipeline

The Jacobs School of Engineering views engineering education as a pipeline that starts with outreach and summer programs for K-12 students and continues as those students become undergraduates, graduate students and working professionals. Along the way, individuals have the opportunity to develop both high-level technical know-how and the professional skills they need to become leaders in the technology economy.

Thanks to a generous gift from Irwin Zahn and his family through their Moxie Foundation, the Moxie Center for Undergraduate Entrepreneurship is the latest resource added to the talent pipeline. The Moxie Center provides an incubator for students to prototype and test their ideas.

"We believe that all students participating in our incubator will enhance their technical education by gaining experience understanding why products are built, who will benefit and who will pay—the keys to successful innovation," said Jay Kunin, the center's director, and an entrepreneur with a long record of success.

In May, after just five months in operation, the Moxie Center awarded its first-ever Zahn Prizes—and a total of $10,000 in cash—to three teams of students that presented the best business plans. A team of mechanical engineers won the grand prize of $6,000 with an idea to use solar umbrellas to provide electrical outlets at outdoor cafes. The team includes seniors Sara Taghizadeh (right), who graduated in June, Austin Steussy and Faizan Masood. The team already has a prototype that it is preparing to test at the Price Center on campus.

Second place went to freshman Uzair Mohammad of Saaf Engineering Solutions, who received $3,000 for his method of growing a biological filter for drinking-water purification. Third prize was awarded to Kevin Liang and Eric Suen, of Aqua Design Innovations, who received $1,000 for their aquaponics business model. Liang is a third-year biology major and Suen is a sophomore studying economics. Irwin Zahn said he hopes the Moxie Center energizes more students from all academic disciplines to participate in this unique opportunity to explore how to turn their business ideas into reality.

The process of developing a technology, and a business plan to sell it, is what's essential about the Moxie Center. "They have to develop something. They have to put together a plan. They have to present it and defend it in response to questions," said Zahn. "So even if you lose you really win. The reason you win is because it's training, so the next time you'll do even better."

Mechanical engineer Sara Taghizadeh is part of the team that won first place in the Zahn Prize for their solar umbrellas, which are designed to provide electrical outlets at outdoor cafes. Learn more: JacobsSchool.ucsd.edu/moxiecenter

Alumni Crowdsourcing Venture Acquired by Satellite Imaging Co.

Every day, satellites take high-resolution pictures of the Earth. But it is almost impossible for humans to review these billions of pixels of information. Enter Tomnod, a start-up co-founded by four alumni of the Jacobs School of Engineering who have harnessed crowdsourcing to sort through all these pixels. Their company was recently acquired by Colorado-based DigitalGlobe, a leading supplier of commercial satellite imagery.

The best applications for the technology are search and rescue operations during natural disasters. Tomnod has launched crowdsourcing campaigns to examine satellite images of the damage from the tornado that ripped through Oklahoma on May 20 and from Hurricane Sandy last year, among others.

"This really goes with the nature of crowdsourcing," said co-founder Luke Barrington, who earned his Ph.D. in electrical engineering from the Jacobs School. "People want to have an impact. They want to help."

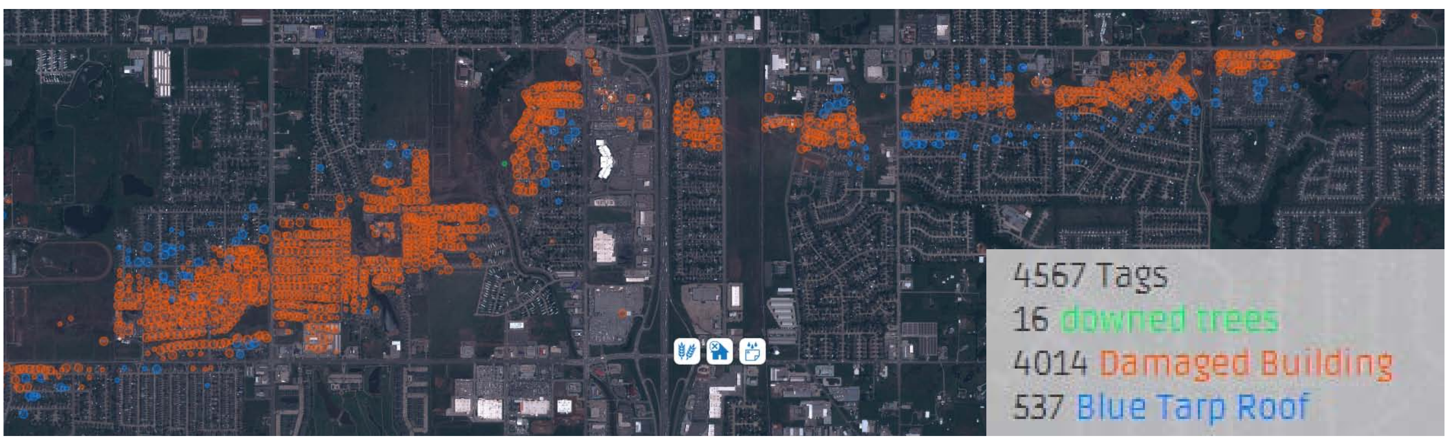
Tomnod, which means big eye in Mongolian, uses sophisticated machine learning algorithms to analyze images tagged by human users and determine which ones are the most likely to include useful information. "At first, we tried to extract the information with machine learning only," said Barrington. "But there was just too much to process."

Barrington met with fellow Tomnod co-founders Albert Lin, Nate Ricklin and Shay Har-Noy when they were engineering Ph.D. students working on the same floor at Calit2, now the Qualcomm Institue. The approach Tomnod uses was originally designed for the Valley of the Khans Project, an effort led by Lin, supported by the National Geographic Society and aimed at finding the tomb of Genghis Khan in Mongolia. With the success of that project, they decided to see what else their approach could be applied to.

Tomnod benefited from the support of EvoNexus, a start-up incubator in San Diego, which provided mentorship and facilities. "We were all working from home and were homeless in a way, when they arrived and helped us out," Barrington said.

After it was acquired by DigitalGlobe, Tomnod became an independent division within that company.

"At DigitalGlobe, we can keep pursuing our vision of crowdsourcing the world," Har-Noy said.



A map of the damage caused by a tornado that ripped through Oklahoma on May 20, 2013. Tomnod users flagged damaged buildings, downed trees and blue tarp-covered roofs. Visit tomnod.com to crowdsource the world with Tomnod and DigitalGlobe.

Computer Science Startup LonoCloud Acquired by ViaSat

Satellite communications company ViaSat has acquired LonoCloud, co-founded by Ingolf Krueger, a professor of computer science and engineering at the Jacobs School with an adjunct appointment at the UC San Diego Rady School of Management. LonoCloud has developed an innovative, cloud-based service platform to support the "Internet of Things."

"We are very excited to join ViaSat, which will allow us to continue building out our technology, while joining forces with an innovator in the field of satellite and other digital communication products," said Krueger.

LonoCloud's software system contains sophisticated, distributed mesh algorithms that create a network foundation for enterprise services and applications to interact and communicate with one another—the "service fabric." This next-generation cloud computing architecture runs as an overlay to enterprise network environments, enabling low-cost, distributed computing across multiple servers in the cloud.

The service fabric provides real-time software updates for minimal operational disruption and downtime, as well as policy-driven scalability and dynamic configuration. Providing these capabilities as building blocks to distributed applications is key to high availability and resiliency at a global scale.

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