SAMUELI SCHOOL OF ENGINEERING
UNIVERSITY of CALIFORNIA • IRVINE

2013 Dean's Report

content

2013 Dean's Report

UCIrvine | The Henry Samueli School of Engineering

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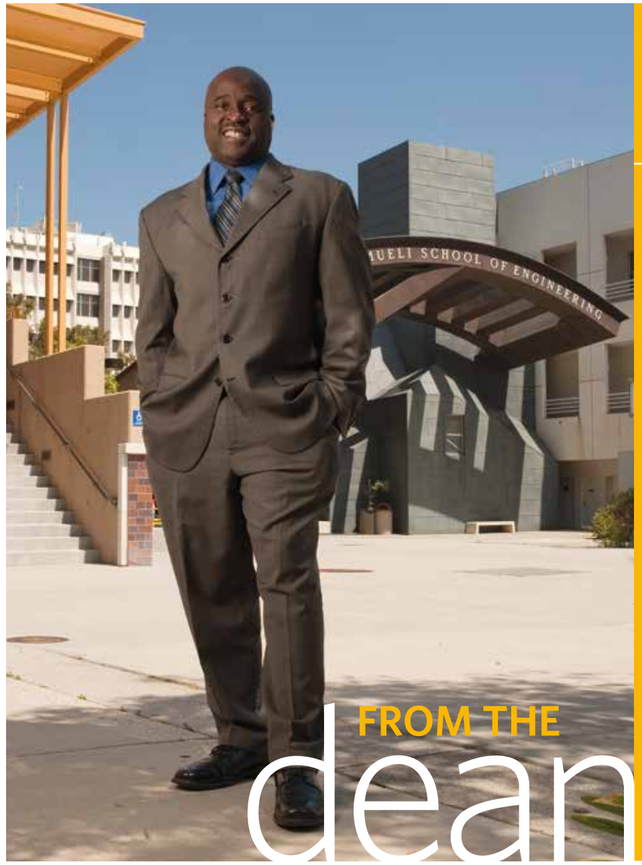
Cover: A Southern California morning is reflected in the windows of Engineering Hall, the newest building to open on the Samueli School quad. It has received LEED Platinum certification by the U.S. Green Building Council.



FROM THE dean

THE SAMUELI SCHOOL DIFFERENCE

With engineering as the driving force in economic areas such as healthcare, communications and sustainability, it is critical to rethink what it means to be an engineer. While there has been strength in the conventional engineering disciplines for centuries, today's global complexity is placing new demands on how we live, learn and work. With this in mind, our strategic plan for the Samueli School places leadership and innovation as foundational elements for educating tomorrow's engineers.

This past year, we've launched our freshman experiential learning program, giving more than 100 engineering undergraduates a design, build and test experience from day one. The first in the University of California system, this program offers UC Irvine students a competitive advantage. We have also restructured our student projects and internship programs, providing many more experiences at every academic level. Our highly intensive, one year Master of Science in Engineering Management degree with the Paul Merage School of Business proudly graduated its first class.

We've created unprecedented opportunities for engaging students and faculty with industry. Within two months, a newly created jobs website attracted 700-plus students and alumni, and more than 375 companies looking for high-tech talent. In the past year, the Samueli School's Design in Industry program has inspired student teams to take the lead in solving a dozen local companies' design challenges.

Through focused research efforts, we have established six new programs to help faculty expand their activities across campus, and across continents.

We received our third consecutive prestigious W.M. Keck Foundation award. The $1 million grant has inspired a unique collaboration between Samueli School and the School of Physical Sciences. Additionally, a civil and environmental engineering team has been selected to spearhead a $4.8 million NSF-funded collaboration between Australian and southwestern U.S. partners.

We also are proud that our faculty submitted 32 applications for Small Business Innovation Research grants, more than triple our previous high.

As I embark on my third year as dean, I am proud of the progress we've made to *unleash innovation, create opportunities* and *inspire ingenuity.*

More students are making the Samueli School their choice for an engineering education like none other, as demonstrated by the largest incoming class in our school's history. While the challenges associated with increased student demand and a difficult budget climate remain, we are bolstered by our continued resilience in education initiatives and research.

This inaugural issue of the *Dean's Report* captures just a handful of our school's faculty and student accomplishments to illustrate how UCI engineering technologies and ideas are making a societal difference.

Gregory Washington
Dean, Samueli School

93%

increase in issued patents from previous year

$68.9

million in research expenditures FY 2012-13

2/3

of all engineering undergraduates participate in faculty-mentored research

unleashinginnovation

Through research that pushes boundaries, the Samueli School unleashes innovative ideas and technologies that impact the economy and benefit society.

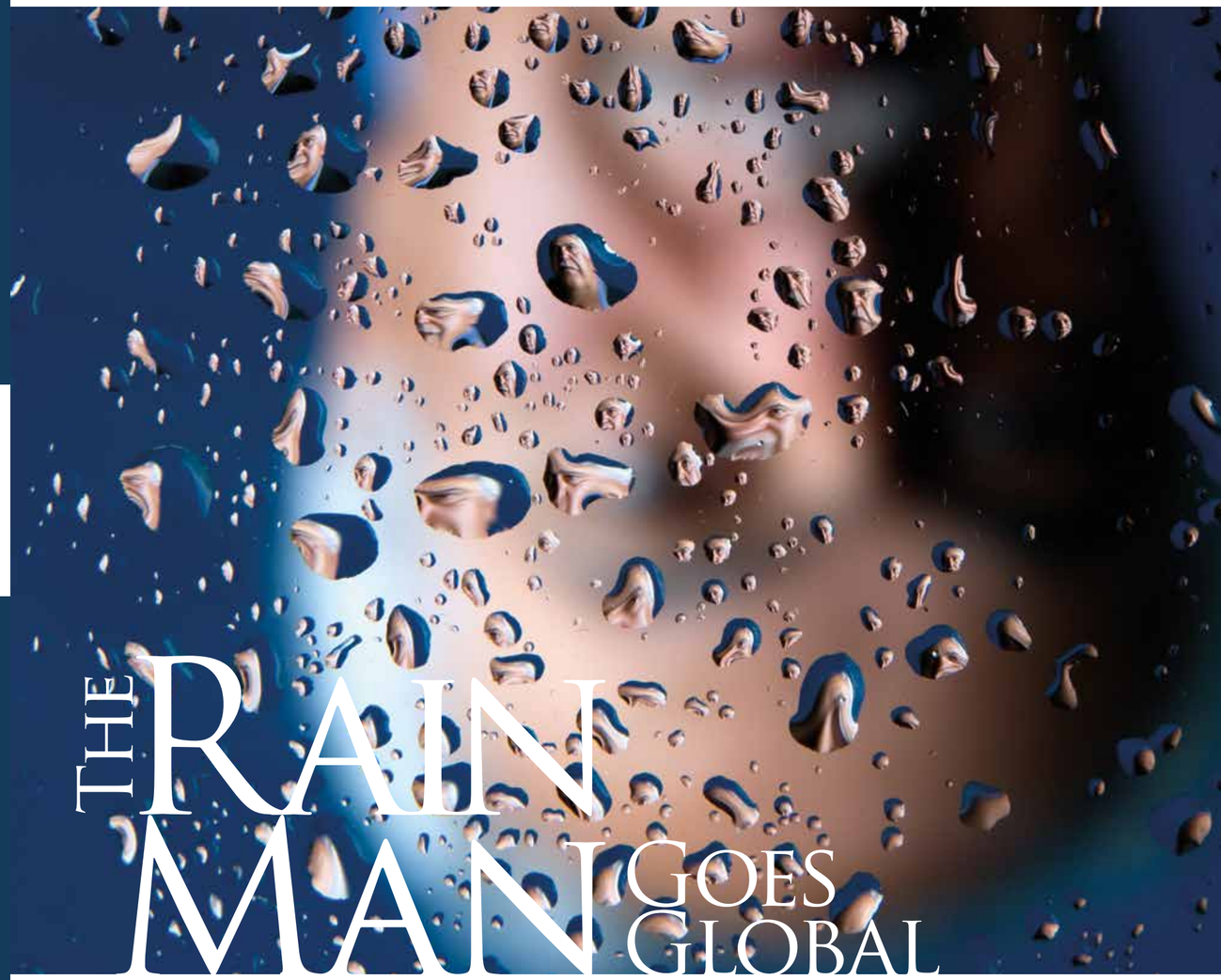
PRESTIGIOUS**SCHOLARS**

1 DOD Graduate Research Fellowship

2 NASA Graduate Research Fellowships

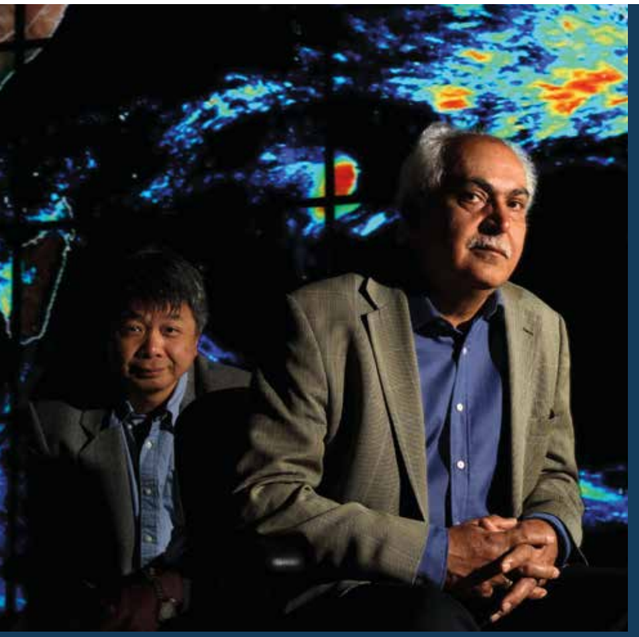
3 NSF EAPSI Graduate Awards

5 NSF Graduate Research Fellowships



THE RAIN MAN GOES GLOBAL

PRECIPITATION TRACKING TOOL HELPS COUNTRIES PREDICT AND PREPARE FOR INTENSE RAINFALL | by Lori Brandt



Above: Kuo-lin Hsu (left) and Soroosh Sorooshian produce online maps and other data used by people around the world to foresee where and when heavy rain will hit and to brace for possible floods, mudslides and other disasters.

At right: Sorooshian displays the G-WADI GeoServer in UCI's Center for Hydrometeorology and Remote Sensing.

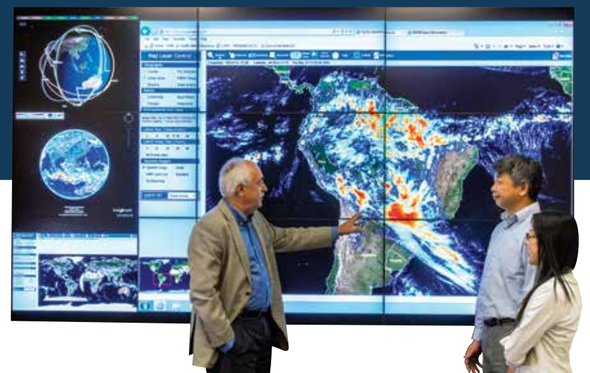
From Hurricane Sandy to the heat wave in Brazil, flash floods in Pakistan to drought in Africa, snow storms in Jerusalem to bush fires in Australia – extreme weather events around the world are breaking records, and they are expected to increase with climate change, according to many scientists.

"The warmer the air temperature, the bigger the atmosphere's appetite for water vapor. So it is expected that as our planet gets warmer, the hydrologic extremes, such as floods and droughts, may become more frequent," explains Soroosh Sorooshian, a UC Irvine Distinguished Professor of civil and environmental engineering and director of the Center for Hydrometeorology and Remote Sensing (CHRS). The center's mission is to build global capacity for forecasting and mitigating hydrologic disasters.

"To better predict extreme weather conditions, we need reliable, accurate data," Sorooshian explains.

He and his team at the CHRS recently joined forces with the United Nations Educational, Scientific and Cultural Organization (UNESCO) to improve forecasting worldwide. They developed a service that provides global, near real-time rainfall information, via the Internet. Called the CHRS Hydrologic Data and Information System G-WADI GeoServer, this online weather tool uses remote sensing technology to tap into weather data from NASA and NOAA satellites. With a mathematical modeling approach, it processes different electromagnetic signals picked up by satellites from clouds and storm systems, converts them into rain estimates and projects them via colors on a Google map of the Earth.

Since the G-WADI GeoServer was established in 2010, it has had more than 3.5 million hits from all over the world. It provides online maps and hydrologic models to help governments see where and when heavy rain will hit. The high-resolution precipitation information and estimates can be retrieved from any desktop or laptop computer. Users can print reports that show precipitation in three-hour, six-hour or daily increments. Maps show precipitation during the most recent 72-hour period on a global, regional or local level, right down to a 100-kilometer-square area.



chrs.web.uci.edu

It is useful for government officials and climate researchers, but it can also benefit anyone with an interest in rainfall. Imagine the rice farmer in Vietnam, the goat herder in Kenya, or the fisherman in Samoa.

"We are proud of developing this partnership with UNESCO and being able to provide an open source product, particularly to developing nations," says Sorooshian, "Rainfall, or lack of it, affects everyone in some way, rich or poor."

A member of the National Academy of Engineering, Sorooshian is a founding member of UNESCO's Water and Development Information for Arid Lands: a Global Network – known as G-WADI – and he has garnered international awards recognizing his contributions. Anil Mishra, a program specialist with UNESCO's International Hydrological Programme, said the G-WADI GeoServer was used to analyze precipitation during the devastating 2010 floods in Pakistan. It has since received more than 61,000 hits from sources in that country.

"Pakistan has a well-established rain gauge network and weather radar system, but as with any ground-based observation system, there are spatial and temporal issues and problems with high terrain," Mishra says. "Satellite observations help overcome some of these limitations. From their vantage point in orbit, satellites continuously monitor the entire region and aren't impeded by mountain ranges."

Samueli School Associate Professor Kuo-lin Hsu developed the algorithm employed by the center to effectively monitor continuous rainfall amounts. Called PERSIANN, this mathematical modeling approach is used by hydrologic services worldwide for flood forecasting. "We are continually developing this algorithm to improve and retrieve better data," says Hsu. "For climatologists, who look at changes over a longer period, we are establishing a daily climate record."

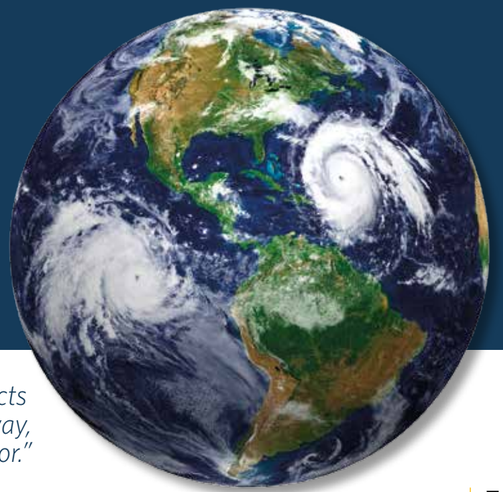
This new online product is retrospective for the U.S., going back to 1980. The climate data record (CDR) will provide daily satellite-based, high-resolution precipitation information, allowing users to study current rainfall estimates in comparison to historical information. Being compiled by Hamed Ashouri, a UCI doctoral candidate in civil engineering, the CDR will become the permanent climate record maintained by NOAA's National Climatic Data Center, and it will be available to the public.

"As a global fine-resolution precipitation data set, the CDR can be used by climatologists for global climatological studies at a finer resolution than was previously possible, and by hydrologists for rainfall-runoff modeling, particularly over ungauged basins and remote regions," explains Ashouri. "It also gives us the ability to observe potential changes in the frequency and duration of extreme precipitation events in the climate over the past 30 years."

This historical perspective is important for those studying extreme weather and climate change. The CHRS team of four faculty, two research scientists and 10 doctoral students, is dedicated to tracking the increasing activity.

"Our products evolve as our team grows," says Hsu. "Precipitation information is very important. We can stop a lot of problems and make significant contributions, especially in remote areas, with accurate precipitation data."

Since the G-WADI GeoServer was established in 2010, it has had more than 3.5 million hits from all over the world.



"Rainfall, or lack of it, affects everyone in some way, rich or poor."

Searching for a Signal

RESEARCH TEAM IS ON A MISSION TO FIND EVIDENCE OF THE ELUSIVE NEUTRINO | by Lori Brandt

Growing up, Stuart Kleinfelder had an affinity for physics and a fascination for the history of polar exploration. So it was a dream come true for the UC Irvine electrical engineer to travel to Antarctica on an NSF-funded project aimed at capturing evidence of cosmic neutrinos.*

Kleinfelder and his team – two graduate students and a research scientist – braved below-freezing temperatures and harsh Antarctic conditions for two weeks last November. They flew by helicopter from McMurdo Station to the middle of the Ross Ice Shelf where they were dropped with two tents, supplies and their equipment. They worked long days to set up instrument stations for the project, called the Antarctic Ross Ice Shelf Antenna Neutrino Array (ARIANNA). The stations, including the autonomous radio-frequency electronics instruments, were designed by Kleinfelder to listen for radio signals sent from high-energy neutrinos as they pass through and interact in the ice.

The associate professor at the Samueli School says that working in Antarctica was an exciting adventure, but difficult. "At first, you can't stop violently shivering and your metabolism goes into overdrive," says Kleinfelder. "It's so cold, your gloves can't be off for more than a minute or you risk frostbite. Your body needs so much fuel to stay warm that we were always hungry."

The sun never sets at that time of year, and temperatures ranged from freezing to about 0 Fahrenheit (32 below freezing). The team labored, digging holes in the ice to place the stations, from morning until late at night, sometimes midnight. They stopped early, around 9 p.m., on Thanksgiving to heat up a meal of frozen Pad Thai.

"The hardest part was being in a completely remote area and battling brutal weather conditions," says Ziggy Fan, an electrical engineering graduate student who went on the trip. Fan said Antarctica was captivating. "The minute we got off the cargo plan, it was breathtaking to see the beauty of Mother Nature in its most stunning and powerful form. I particularly enjoyed the helicopter rides; it felt like my teammates and I were in a movie and on a secret mission."

"This experiment required novel technology and instrumentation, the domain of engineers, not physicists."

** The first detection of the neutrino was made by Frederick Reines and Clyde Cowan in the 1950s. Reines was a UCI professor and founding dean of physical sciences and recipient of the 1995 Nobel Prize in physics for his contribution to the discovery.*

This page, clockwise from top:

Researchers camped for two weeks on the Ross Ice Shelf, a floating ice sheet measuring roughly the same size as France. Ninety percent of the shelf is underwater.

Researchers loaded equipment on a sled, which they pulled by snowmobile to the ARIANNA installation site.

In the science tent, Corey Reed, an associate project scientist in physics and astronomy, tested the detector system before installation.

Opposite page, clockwise from top left:

Engineering professor Stuart Kleinfelder arrived at McMurdo Station after a six-hour flight from New Zealand on a U.S. Air Force cargo jet.

The view of Antarctica from the plane.

The research team traveled by helicopter from McMurdo Station to the Ross Ice Shelf.

The team (from left) – Associate Professor Stuart Kleinfelder, Associate Project Scientist Corey Reed, engineering graduate student Ziggy Fan, and physics and astronomy graduate student Joulien Tatar – atop Observation Hill.

Scientists around the world *are* on a mission. They've established neutrino detectors in underground mines, in the ocean and in Antarctic ice.

Neutrinos are important because they could provide insights into how the universe was formed, how large it is, and what will ultimately happen to it. UCI astrophysicist Steve Barwick conceived the ARIANNA project. "We think neutrinos may hold the secrets to understanding the beginning of the universe," says Barwick, who has been studying neutrinos for two decades.

Tiny, almost massless subatomic particles that travel at near light speeds, neutrinos are emitted in huge numbers by stars, including the sun. These astronomical messengers journey to earth as cosmic rays, and they are all around us, all the time, in enormous numbers. But they are notoriously difficult to pin down and study because they do not readily interact with other forms of matter.

For help in detecting the mysterious particles, Barwick turned to Kleinfelder, who has more than 25 years of experience designing highly advanced and novel integrated circuits and systems. Kleinfelder invented the Switched Capacitor Array and Advanced Transient Waveform Digitizer (ATWD) data acquisition circuit techniques now in ubiquitous, worldwide use in particle physics, nuclear science and astrophysics.

The stations are the first high-performance instrumentation to survive autonomous operation in desolate, cruel Antarctic conditions.

"This experiment required novel technology and instrumentation, the domain of engineers, not physicists," Barwick explains. "We needed a device that was low power, but highly reliable, and cheap enough to be able to replicate. Stuart's unique skills were a huge asset."

Kleinfelder and his team have devised a detector set-up that takes into account the site's brutal conditions.

Each ARIANNA station has four antennas that are buried six feet into the ice. At the heart of the station are four custom-made "smart" ATWD chips containing a fast pattern-

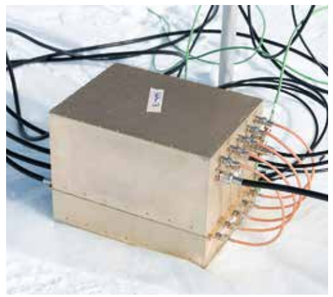
matching trigger that searches through incoming waveforms in real time, constantly looking for specific signals that researchers suspect are from high-energy neutrinos. Operating at two gigahertz, this chip has far greater timing stability than any previous generation, and its smart trigger promotes high efficiency in capturing neutrino signals and rejecting noise.

The stations all have wireless and satellite communications capability. The digital data is sent via long-range wireless to Antarctica's McMurdo Station and then via satellite communications to a computer at UCI. The stations are primarily solar powered, with wind power and a battery as backup. The key to their design is that they rely on very little power – in Antarctica, there is no sun during six months of winter and intermittent winds. The stations are the first high-performance instrumentation to survive autonomous operation in desolate, cruel Antarctic conditions.

The ARIANNA research project is in its early stage, with just four detector stations installed thus far. Ultimately, the project will include more than 900 detectors spread across the 182,000 square-mile Ross Ice Shelf.

Kleinfelder says that once fully implemented, ARIANNA will cover more mass than any other current neutrino detection experiment. This, he hopes, will increase their chances of catching extremely rare and energetic neutrinos that are coming from powerful supernovae, the galactic core and elsewhere. He is optimistic.

"ARIANNA seeks understanding of some of the last deep mysteries in particle astrophysics. Both personally and professionally, it's a grand adventure. With this project, we are the next generation of polar explorers, literally traveling to the ends of the earth to touch the stars!"



Top: The communications tower with two antennas – one for satellite and one for long-distance wireless. The poles with green flags indicate where the neutrino-detection antennas are buried deep into the ice. The power tower topped with a wind turbine sits in the background.

Bottom: The heart of each station is the instrumentation box, which contains the custom electronics technology that sifts through the noise and captures potential radio frequency signals from cosmic neutrinos. Each instrumentation box is protected in plastic.

facultyfeats

AT THE APEX

UCI Distinguished Professor **SATYA ATLURI** received the 2013 Padma Bhushan award "for distinguished service of high order in the field of engineering and science." The honor is considered India's third-highest civilian award. Atluri traveled to New Delhi to receive his award from President Pranab Mukherjee. He was told it was the first such civilian honor conferred upon anyone in the University of California system. Atluri is a mechanical and aerospace engineer and director of the Center for Aerospace Research and Education at the Samueli School. His widely cited research spans several disciplines and has led to greater aircraft safety and durability. "I want to share my immense joy on this occasion and thank UCI for giving me a job and an opportunity to think, to teach and to publish," he said after first learning of the recognition.

ON THE RISE

It has been a productive year for Samueli School's **ANIMA ANANDKUMAR.** Most recently, the assistant professor of electrical engineering and computer science received a 2013 Microsoft Research Faculty Fellowship – one of seven from around the world to receive this support. "The past winners of this award have gone on to do cutting-edge innovative research, and it inspires me to follow their lead," explains Anandkumar, whose interdisciplinary research spans machine learning, statistics, signal processing and optimization. Earlier in the year, she was awarded an ARO Young Investigator Award and an NSF CAREER Award for her work on "modeling dependencies via graphs: scalable inference methods for massive datasets." Anandkumar joined the UCI faculty in August 2010. She spent a year as a postdoctoral researcher at MIT and earned her doctorate from Cornell University.

facultyfeats

A LIFE OF ACCOMPLISHMENT

UCI Chancellor's Professor **CHEN TSAI** has devoted nearly half a century to seeking innovation in the field of electrical engineering and applied science. His efforts were recognized by the IEEE Ultrasonics, Ferroelectrics and Frequency Control Society, which gave him its 2013 Lifetime Achievement award. Tsai, who came to the Samueli School in 1980 from Carnegie Mellon University, was recognized with the society's highest honor for his pioneering contributions to the science and technology of integrated acousto-optics and magneto-optics, scanning acoustic microscopy, and ultrasonic monodisperse micro-droplet generation. "I'm extremely honored, and I share this recognition with all of my former and current research students and visiting scholars," says Tsai.

A SIGNIFICANT CONTRIBUTION

In recognition of outstanding contributions to the communications technology field, UCI Chancellor's Professor, **HAMID JAFARKHANI,** department of electrical engineering and computer science, is a co-recipient of the 2013 IEEE Eric E. Sumner Award. The collective work of Jafarkhani and two colleagues has helped the wireless communications industry improve quality of service and increase network capacity and has been a key enabler for fourth generation OFDM/MIMO systems. The trio's research has greatly influenced the standardization, commercialization and advancement of space-time codes. In particular, the award citation called out Jafarkhani's effort "to extend the performance of space-time codes by introducing the quasi-orthogonal space-time block code."

NEW INNOVATOR

WENDY LIU, assistant professor of biomedical engineering, garnered a 2012 National Institutes of Health Director's New Innovator Award for her work on immune system response to biomaterials used in medical devices. "Our strategy harnesses the body's potential to control inflammation and promote healing, which will hopefully prevent device failure and, ultimately, help cure life-threatening diseases," says Liu, who's associated with The Edwards Lifesciences Center for Advanced Cardiovascular Technology in the Samueli School. Her goal is to design biomaterials coated with molecules naturally expressed by host tissue. These molecules are the body's way of regulating immune tolerance to host tissue as well as the healing response to wounds. Liu believes this approach is better than harsh immunosuppressive therapies.

HEARTY CONGRATULATIONS

DR. ARASH KHERADVAR, assistant professor of biomedical engineering, has been elected a Fellow of the American Heart Association. Kheradvar was elected to fellowship by the AHA Council on Cardiovascular Radiology and Intervention in recognition of his major contributions to cardiac imaging and image-based modeling of cardiovascular diseases. "It could never have happened without the hard work and dedication of my research group over the past years," says Kheradvar. "I look forward to furthering my efforts toward the AHA's mission, which is to build healthier lives, free of cardiovascular diseases and stroke." His research focuses on cardiovascular engineering with an emphasis on new cardiac imaging technologies, cardiac mechanics and novel heart valves.

FRESH FACES

Four new assistant professors joined the ranks of Samueli School leading faculty in the 2012-13 academic year.

CHANG LIU joined the biomedical engineering faculty after serving as a Miller Postdoctoral Fellow at UC Berkeley. He earned undergraduate and doctoral degrees in chemistry from Harvard and Scripps Research Institute, respectively. His research is in synthetic biology, chemical biology and directed evolution. His unique expertise makes him a powerful collaborator in the study and modeling of biological phenomena and the manipulation of genetics for biomedical use.

KRISTEN DAVIS earned her doctorate from Stanford and has worked with many of the world's top researchers in coastal oceanography and environmental fluid mechanics. Her research involves careful field observations of flow and turbulence in shallow coastal water systems to understand how complex near-shore flow fields influence the transport of biological material. Her work has applications in prediction and mitigation of harmful algal blooms, die-off of coral reefs, and near-shore pollution from human sources. She brings complementary expertise to our water and hydraulics faculty in the civil and environmental engineering department.

ELIZABETH READ earned her doctorate in chemistry from UC Berkeley and served as a Frederick M. Richards Postdoctoral Fellow at MIT. Read's postdoctoral research involved using methods rooted in statistical mechanics and engineering to understand the human immune response to HIV for designing a vaccine. She joined the chemical engineering and materials science department, where her research blends the physical, life and engineering sciences with medicine to solve important systems biology problems.

MOHAMMAD AL FARUQUE joined the department of electrical engineering and computer science as the Emulex Career Development Chair. He received his doctorate from the University of Karlsruhe, Germany, and most recently worked at Siemens Corporate Research, where he focused on scheduling and control algorithms for next-generation cyber-physical systems for use in smart power grids, electric vehicle charging and energy-efficient buildings. He brings a special interest in system-level design of embedded and cyber-physical systems, complementing existing faculty strengths.

32%

nearly a third of the Samueli faculty are named Fellows

A NEW ACS FELLOW

MARTHA MECARTNEY, professor of chemical engineering and materials science, has been named a Fellow of the American Ceramic Society; she is among 18 Fellows chosen in 2013. "It is an incredible honor to be selected as a Fellow among such esteemed colleagues, and I am delighted," says Mecartney, whose research is in the development of new multiphase oxide ceramics for energy applications, understanding how grain boundaries and interfaces control physical and chemical properties, and analytical transmission electron microscopy. "What's taken me by surprise is the outpouring of congratulations from around the world." An international cross-section of leaders in academia, research labs, industry and government, the new Fellows will be recognized in October at the society's annual honors and awards banquet in Montréal, Québec, Canada.

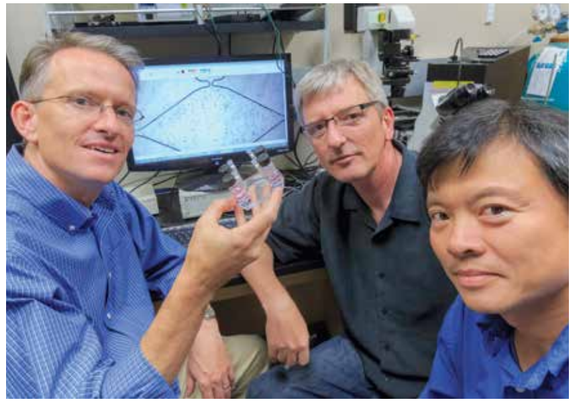
CAREER AWARD

The National Science Foundation has recognized **TIMOTHY RUPERT** with a 2013 CAREER Award. Rupert is an assistant professor in the departments of mechanical and aerospace engineering, and chemical engineering and materials science. The award supports Rupert's research involving the grain boundary network of nanocrystalline metals. He is investigating how the boundaries fit together and connect, and then exploring ways to alter the boundary network with the goal of improving the properties of the material. Rupert has been conducting research on nanocrystalline materials for seven years, since he was an undergraduate, and is encouraged by the NSF's support. "It's nice to know they think I have a good idea," notes Rupert.

SPEARHEADING AN INTERNATIONAL WATER PROJECT

Civil and environmental engineer Stan Grant and his research group were selected by the National Science Foundation to spearhead a $4.8 million collaboration between Australian and Southwestern U.S. partners. The UCI Water-Partnerships for International Research and Education (PIRE) will catalyze, through research and education, the development and deployment of low-energy options for improving water productivity while protecting human and ecosystem health. The project links five universities in two water-stressed regions of the world that have unique and complementary expertise in using rainwater tanks, biofilters and waste stabilization ponds for potable substitution and watershed protection.

"It's an absolute dream to be given this opportunity by the NSF," Grant says. "The Southwestern U.S. has much to learn from Australia on how to thrive in the face of dwindling freshwater supplies." The goal of the project is to translate the Australian experience into practical steps California and other states can take to improve water productivity.



SOPHISTICATED TISSUE CHIPS FOR TESTING CANCER DRUGS

With a $1 million National Institutes of Health award, Dr. Steven George, professor of biomedical engineering, has assembled an eight-member multidisciplinary team that is building 3-D perfused artificial tissue chips. These engineered microsystems will mimic the physiology and biology of cardiac and cancer tissues, and will be used for testing the safety and efficacy of cancer drugs before they are tested in people. One day they could even replace human clinical trials.

"We believe reproducing this complexity is necessary to mimic more closely the human response to new drugs," explains George, who also directs Samueli School's The Edwards Lifesciences Center for Advanced Cardiovascular Technology. "We chose cancer tissue and cardiac tissue to simulate together because cardiac side effects are a common reason that new anti-cancer drugs fail in pre-clinical and clinical trials."

The grant is one of only 17 awarded nationally by the Tissue Chip for Drug Screening Initiative, which seeks to improve the process for predicting drug safety in humans.

3

W.M. Keck Foundation Awards in three years

A UNIQUE DEEP-OCEAN POWER SCIENCE LAB

The W.M. Keck Foundation granted $1 million to UCI to build a campus laboratory in which researchers can explore the potential of using the deep ocean's low-temperature and high-pressure conditions to generate carbon-free power from methane hydrates. Three-dimensional, ice-like structures with natural gas locked inside, methane hydrates are found under the Arctic permafrost and in ocean sediments along nearly every continental shelf in the world. They're difficult to recover, though, because they require low temperatures and high pressure to remain solid. The new laboratory will investigate novel strategies for utilizing the natural gas contained in methane hydrates through high-pressure combustion and for immediately capturing and mitigating any carbon dioxide emissions. The Deep-Ocean Power Science Laboratory, being built in the Engineering Gateway building, is a joint project of the Samueli School and School of Physical Sciences.

"This will be the only facility in the world capable of examining both high-pressure combustion and carbon sequestration," says Derek Dunn-Rankin, professor and chair of mechanical and aerospace engineering and lead investigator on the project. "By conducting these studies in a controlled setting, we aren't jeopardizing the ocean. And by learning how to handle methane hydrates, we can determine a scientific basis for making rational decisions about how to safely and wisely use them."

The deep-ocean project marks the third year in a row that the W.M. Keck Foundation has awarded $1 million grants to Samueli School professors. In 2012, electrical and computer science engineer Kumar Wickramasinghe received funding to develop new equipment for the analysis of messenger ribonucleic acid levels in space and time within a living cell; in 2011, a trio of biomedical researchers led by Enrico Gratton used the funds to develop a nanoscale imaging microscope capable of observing single-cell migration in vivo, providing new insight into how cancer cells metastasize in humans.

NOVEL DIABETES TREATMENTS IN SEARCH OF A CURE

Two UCI research groups received $2.27 million from the JDRF to develop innovative methods of treating and possibly curing Type 1 diabetes. The JDRF, formerly the Juvenile Diabetes Research Foundation, awarded one grant to Jonathan Lakey, associate professor of surgery and biomedical engineering, and Elliot Botvinick, assistant professor of surgery and biomedical engineering; and another to Weian Zhao, assistant professor of pharmaceutical sciences and biomedical engineering.

With $1.27 million in funding over three years, Lakey and Botvinick will try to find a way to successfully transplant encapsulated, stem cell-created pancreatic islets. In Type 1 diabetes, the pancreas cannot produce insulin – a hormone key to regulating carbohydrate and fat metabolism in the body – making daily insulin treatments necessary. In a previous study, Lakey helped show that transplanted encapsulated islets can create and secrete insulin. A major hurdle, though, is overcoming immune-system rejection of these transplanted islets.

With the other grant, Zhao and his colleagues will try to develop an insulin sensor for the JDRF's Artificial Pancreas Project, which supports the creation of an automated system to dispense insulin based on real-time changes in blood sugar levels. Zhao will receive $1 million for the two-year effort, with the potential for further funding if his team comes up with a promising model. "Integrating a real-time insulin sensor into the artificial pancreas system will allow us to precisely monitor and control the levels of both sugar and insulin, ultimately leading to safe and effective management of diabetes," he says.

375 TECHJOBS.UCI.EDU **700**

375 companies and more than 700 students and alumni sign on with new high-tech jobs website

3 new global relationships established

creatingopportunities

Through strategic partnerships and novel collaborations, the Samueli School creates opportunities for mutually beneficial and productive results.

UCI-mentored MESA teams win national championships four times in eight years

4

50 established novel strategic partnerships with 50 regional companies

A Change That MATTERS

LEADING-EDGE FUEL CELL SCIENCE EMPOWERS A WASTEWATER FACILITY | by Anna Lynn Spitzer

Sewage is undergoing an amazing transformation at the Orange County Sanitation District in Fountain Valley, Calif.

Thanks to a project that originated at UC Irvine, biogases produced by the sludge as it sits in giant holding tanks are used to power an on-site fuel cell, producing hydrogen fuel for next-generation vehicles while simultaneously generating electricity and heat to run the facility.

The process, known as tri-generation, is the brainchild of Scott Samuelsen and Jack Brouwer, engineering professors at the Samueli School.

The idea took root, as great ideas often do, in a brainstorming session, circa 2002. And as great ideas are wont to do, it took a rather circuitous route to implementation.

At the time, the U.S. Department of Energy's National Fuel Cell Research Center at UCI's Samueli School had been operating for four years, and its director, Samuelsen, and associate director, Brouwer, were pondering how to go about integrating fuel cells with gas turbines, a process called hybrid generation.

THE MODEL IS THE WORLD'S FIRST, BUT MANY MORE ARE EXPECTED TO FOLLOW.

Fuel cells release energy when they catalyze hydrogen and oxygen. Samuelsen and Brouwer were conceptualizing more efficient, environmentally responsible power plants that could not only create electricity but recycle the resulting heat instead of releasing it into the atmosphere.

"We came up with the idea to generate a fuel," Samuelsen says. "And we were starting to see where hydrogen would have to be part of the equation. We were automatically producing hydrogen from the natural gas inside the fuel cell, so what if we just put in a little more natural gas and got a little more hydrogen?"

The NFCRC team set about making it happen. They teamed up with FuelCell Energy Inc., which manufactures ultra-clean stationary fuel cell power plants, and Air Products, a supplier of hydrogen and other industrial gases. After eight years of development and laboratory simulations, the project was ready for testing in a full-scale system.

But how did sewage fit in?

The Department of Energy, which was funding the field demonstration, insisted upon using biofuel instead of natural gas – both are rich in methane – to power the fuel cells. Samuelsen approached the Orange County Sanitation District (OCSD), which readily agreed to participate.

"Renewable fuels will be required for sustainable transportation in the future. This method of converting waste gas into a transportation fuel is one of the most efficient and environmentally sensitive methods there is," Brouwer says.

Imagine: all those cars sitting bumper-to-bumper on the freeway could be getting the equivalent of 70 miles per gallon without spewing anything more harmful than water into the atmosphere, courtesy of humanity's perpetual stream of waste.

The fuel cell uses an electrochemical reaction to generate electricity and heat – used to run the plant – from the hydrogen. The process produces more heat and steam, which, when combined with the treated gases, generates still more hydrogen. The residual hydrogen then is purified, compressed and dispensed into fuel cell vehicles at the on-site filling station.

The amounts of electricity, heat and hydrogen produced by the fuel cell can be adjusted to meet demand. "The great thing about this technology is that you don't have any stranded assets," says Ed Torres, OCSD director of operations and management. "You dial up the hydrogen production when you have the demand from the vehicles, and when you don't, you just dial up the electricity to power the plant."

The first hydrogen-fueled cars pulled up to the pump at the OCSD in August 2011; today, the facility produces about 120 kilograms of fuel per day, enough to fill the tanks of about 30 cars.

Two years in, the project is "going extremely well," says Samuelsen. "This is the epitome of sustainability."

The model is the world's first, but many more are expected to follow. Stationary fuel cells are already installed at many wastewater treatment plants to generate electricity and heat, and he says they can be modified to produce hydrogen fuel as well.

Page 19: Jack Brouwer (left) and Scott Samuelsen (right) of the U.S. Department of Energy's National Fuel Cell Research Center at the Samueli School are collaborating with the Orange County Sanitation District and local industry partners on a project that turns sewage into fuel.

Left: Brouwer pictured with the new "sewage-to-hydrogen" fuel pump at the Orange County Sanitation District in Fountain Valley, Calif.

Imagine: all those cars sitting bumper-to-bumper on the freeway could be getting the equivalent of 70 miles per gallon without spewing anything more harmful than water into the atmosphere, courtesy of humanity's perpetual stream of waste.

Hydrogen-fueled vehicles offer consumers a long list of benefits. Besides supplying three times the mileage, dollar-for-dollar, of their gasoline-fueled predecessors, they are quieter, more responsive and free of hydrocarbon emissions.

The domestic production of hydrogen fuel is a plus, too. "You can almost feel that our petroleum future is very shaky, and it wouldn't take much to dramatically change our access," Samuelsen says.

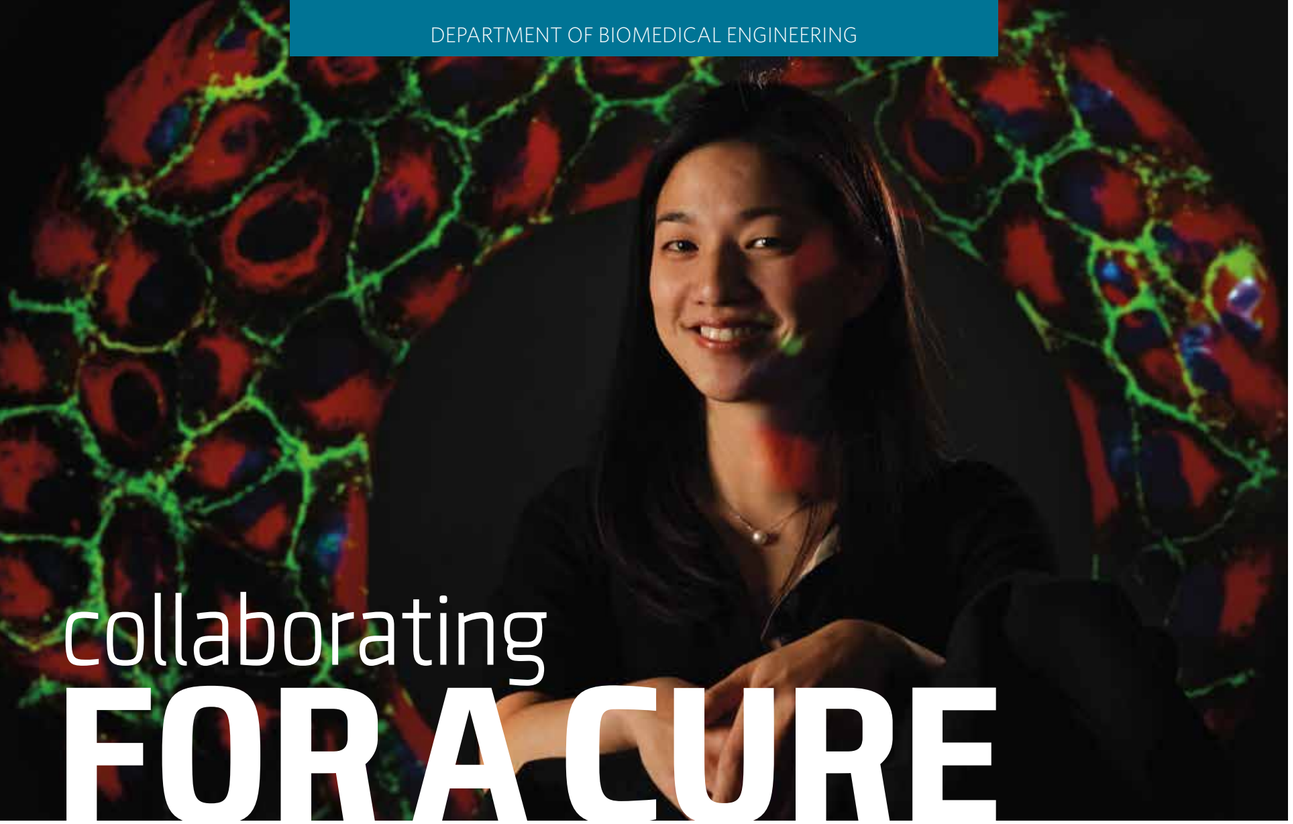
There are approximately 100 hydrogen-fueled vehicles in Southern California, all of which are leased to drivers by the car manufacturers, and there are just a handful of filling stations. But automobile makers including Honda, Toyota, General Motors, Mercedes and Hyundai are gearing up to sell the cars within the next few years, and a hydrogen infrastructure of 68 stations is expected throughout California by 2015 to meet the demand.

The state is requiring that a minimum of 33 percent of all hydrogen fuel sold in California must come from renewable sources, so Samuelsen says, "it's a good bet" many of the new stations that come online will pump hydrogen generated through a sewage waste system like the one at the OCSD.

"This technology is remarkably efficient … and extremely clean and quiet," Brouwer says. "It can be applied to produce hydrogen, power and heat locally from almost any available hydrocarbon gas at the point of need, which can also avert the energy and emissions penalties of fuel transportation."

"The future is wide open," Samuelsen says. "When you have a reliable supply of biogas, there are no impediments to producing renewable hydrogen fuel."

As for the pilot project, Torres says officials are open to seeing the prototype – or a larger system – permanently adopted at the OCSD when the three-year demonstration concludes next summer. "We have an environmental stewardship viewpoint, and we would definitely like to continue to participate if it's in the best interests of the sanitation district and the ratepayers we serve," he says.



collaborating FOR A CURE

NIH NEW INNOVATOR AWARD FUELS ASSISTANT PROFESSOR'S BIOMEDICAL BREAKTHROUGHS | by Shari Roan

Some problems in contemporary medicine seem to evade all attempts at a cure or even a significant therapeutic advance. Paralysis due to spinal cord injury is one example. Type 1 diabetes is another. Even the treatments for atherosclerosis, which affects almost one-third of American adults, are far from ideal.

Today, the field of biomedical engineering is leading the effort to meet those challenges. At UC Irvine, strong ties to many of the county's more than 300 biomedical device or biotech companies provide students and faculty with a distinct understanding of industry's needs, says Abe Lee, chair of the biomedical engineering department and the William J. Link Professor of Biomedical Engineering.

"We get a lot of input from industry," he says. "The biomedical engineering department is unique in that we want our students to think about what they get to do as a profession, which is to directly help people. That starts with a collaborative mindset to engineer solutions for the advancement of human health."

With industry input, UCI's researchers and students address problems relevant to real-life needs and in a manner that produces results, says Stanton Rowe, chief scientific officer for Edwards Lifesciences Corp. in Irvine, Calif. The company's foundation gift established The Edwards Lifesciences Center for Advanced Cardiovascular Technology, an academic-based research and training center at the Samueli School.

"Biomedical engineering, by its design, is an applied science," Rowe says. "One of the most critical skills in biomedical engineering is to work in a team to solve a problem. That wouldn't necessarily jump out at you unless you look at industry practice."

Those values and practices are reflected in Wendy Liu's lab in The Edwards Lifesciences Center, where research is underway that could yield technology to dramatically improve the lives of people who battle serious, chronic health conditions. Liu, an assistant professor of biomedical engineering and winner of a 2012 National Institutes of Health Director's New Innovator Award, is studying the immune system's response to biomaterials used in medical devices. Her approach is designed to overcome problems that have plagued the field of implantable medical devices and prevented the kinds of successful treatments long envisioned by researchers.

After studying cell growth and proliferation while earning her doctoral degree at Johns Hopkins University, Liu spent 18 months working for a company that makes cardiovascular devices. That's when she encountered the challenges of the medical devices field. The essential problem is this: the immune system attacks and tries to reject foreign material. So how do you implant a therapeutic device – such as a cardiovascular stent or insulin-producing islet cells from a pig – into the body and coax it to function without triggering massive, destructive inflammation and scar tissue?

"There's not a lot that's really known about what causes these problems," says Liu. "What about the surface of the material can trigger a certain immune response? We need to understand that at a fundamental level and then try to develop materials that have a better response."

By capitalizing on UCI's collaborative research environment, Liu is making inroads in understanding the microenvironment of cells. Her goals include developing tools using materials and microfabrication to manipulate that environment – prompting positive cell behavior and decreasing inflammation.

"She crosses the boundaries from materials science to the cell biology level," says Lee. "She looks at how the immune system interacts with the material itself and tries to create an interface at the cellular and molecular level."

One of Liu's research projects has a potential application for spinal cord injuries. Researchers have been trying for many years to coax nerve tissue to regenerate by placing a bioengineered scaffold in the damaged area to support new growth.

"The material acts as a scaffold on which the cells can grow, but at the same time the material can also illicit an inflammatory response," Liu explains. "So, how can we balance the two – regeneration and healing – along with promoting cell growth?"

It may also be possible to improve the function of surgical devices like sutures by manipulating the cells' environment. In Liu's lab, proteins are stamped on a plastic material in a photolithographically generated pattern that will attract cells to stick to those proteins in an orderly fashion. She has found that by forcing a cell to become elongated she can control its behavior.

"We want to promote wound healing in addition to preventing a bad immune response," she says. "Most people have been focused on materials that prevent interactions between proteins and cells. They hope that if you prevent any interaction, then you won't get a response. But that hasn't worked. So our strategy is to not only promote interaction but promote a very specific interaction."

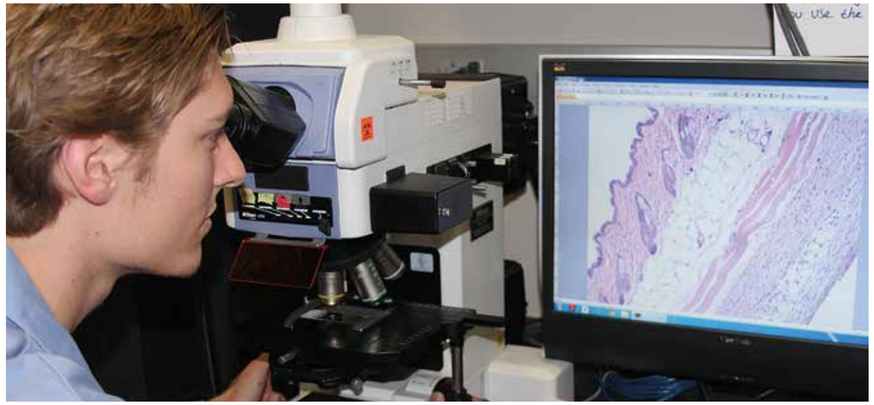
Liu's approach has broad applications to many types of medical devices where scar tissue has traditionally been a problem, such as cardiovascular stents, biosensors and sutures. She is using the NIH New Innovator award to develop immunomodulatory materials that will prevent the body from rejecting islet cells, taken from pigs, that are transplanted as a potential cure for Type 1 diabetes.

"Almost every biomedical engineer has a dream to create a new product that helps patients," Rowe notes. "We have a responsibility to develop and manufacture these products. It's a huge responsibility."

Opposite Page: Assistant Professor Wendy Liu hopes to develop implant coatings that don't trigger a potentially fatal immune system response.

Below: Chase Davis, a biomedical engineering graduate student, looks at a tissue's inflammatory reaction to a material developed in Liu's lab.

"So, how can we balance the two – regeneration and healing – along with promoting cell growth?"



TECHJOBS.UCI.EDU

MOVE OVER MONSTER, TECHJOBS IS ONLINE

More than 700 job-seekers posted profiles on techjobs.uci.edu, a new jobs website developed to connect high-tech companies to students and alumni in UCI's engineering and computer sciences schools. More than 375 companies have signed up with the site to post full- and part-time jobs and internships. The TechJobs website is designed so employers can search the database for a specific skill set, matching companies to Samueli School prospects who meet their needs. In April, several hundred students attended a kick-off event to launch the site. Dean Washington told the crowd that global competition for jobs is tougher than ever. "Our goal with TechJobs is to get all of you registered so you can be connected to the opportunities that are out there," he explains. "There are 1,600 companies in and around Orange County looking for high-tech talent. This website is better than Monster, because it works more like a matchmaker."

72

projects completed for local companies by the Engineering Design in Industry Program over a decade

DESIGN COURSE WITH A MISSION

For the past six years, UCI Chancellor Michael Drake has sponsored a summer team for the Engineering Design in Industry course to work on a project for the Free Wheelchair Mission – an international nonprofit organization headquartered in Irvine that provides free wheelchairs to impoverished disabled people in developing nations. The 10-week design course unites engineering faculty and company-based advisors to provide a unique experience of problem-solving in an industrial context. Each year is a new design challenge, giving students hands-on experience as well as a chance to help a nonprofit agency. The most recent student team created a pressure relief seat cushion, designed to better distribute the weight of the wheelchair user for a more comfortable ride. Last summer's group built an industrial drum tester to analyze the durability and functionality of polyurethane versus pneumatic tires.

MIDDLE SCHOOLERS MEET PROFESSOR FAB

The Samueli School's first ever summer FABcamp for middle school children was a hit, with two sold-out week-long sessions. Run by UCI engineering staff, students and faculty, the camp provided an opportunity for the children to design, build and create projects from start to finish. The budding engineers designed and made their own balsawood airplanes, created a LED display board, built index card structures, a fuel cell, a plastic cast of their thumb and hand-shaken ice cream, among many other engaging hands-on science projects. Working in state-of-the-art UCI laboratories, campers put their critical-thinking and problem-solving skills to work. "The camp gave her a chance to do engineering in a creative and interactive way and to get a broader perspective on what engineers do," says the dad of a seventh grade camper. "On the first day, she came home and wanted to learn how to do new things with (the) circuits. That's as good an outcome as I could have hoped for."

60

middle school children participate in first annual FABcamp

MESA NATIONAL CHAMPS, AGAIN!

Four eighth-grade students from Edwin Markham Middle School in Watts were named middle school champions of the 2013 MESA National Engineering Design Competition. The Markham team is part of the Samueli School's MESA outreach program, an academic preparation program that serves pre-college students who are educationally disadvantaged. The contest involved designing, creating and competing to build the best prosthetic arm device, for less than $40. The students also gave an oral presentation, constructed an academic display and submitted a technical paper. "More than anything else, I think the MESA program demonstrates the great things these kids can accomplish when they are given access to resources and academic enrichment opportunities," says Nicole Patterson, UCI MESA program associate director. "We take great pride in their accomplishments and look forward to watching them realize their limitless potential." The Markham team beat hundreds of other middle school teams through preliminary, regional and statewide contests. They defeated teams from eight other participating states. This is the fourth time in the last eight years a team affiliated with UCI's program has earned the national championship.

A SHOWCASE OF STUDENT INGENUITY

More than 200 industry representatives and community members turned out for Ingenuity 2013, a student technology showcase. The Samueli School joined with UCI's Donald Bren School of Information and Computer Sciences to present the inaugural event, which featured five student teams from each school who demonstrated their award-winning senior design projects. Engineering students wowed the crowd with projects ranging from a portable low-cost diagnostic tool that uses saliva instead of blood to diagnose malaria, to an energy-efficient race car, to Robocam, an automated video-recording system that follows a subject, eliminating the need for a cameraman.

partnerprograms

CONSORTING ON THE FUTURE OF COMMUNICATIONS

The Samueli School and the Iby and Aladar Fleishman Faculty of Engineering at Tel Aviv University jointly hosted a two-day conference last October at UCI. "Communications and Information Technology 2025" brought engineering faculty from both universities together with industry leaders to discuss the future of the communications field. On the second day of the conference, Broadcom co-founder Henry Samueli gave his perspectives in a keynote address on where society is headed in a hyper-connected world. The conference followed an academic mission to Israel, led by UCI Chancellor Michael Drake. The Irvine delegation forged collaborative research agreements, and student and faculty exchanges with Israel's top universities.

MIDDLE EASTERN UNIVERSITY EXCHANGE CREATED

Established in 2012, the Samueli School's Saudi Arabia International Program is a collaboration that seeks to make and strengthen new partnerships with Middle Eastern Universities through a focused student curriculum. The program's aim is to provide international students with extensive English and engineering training for the duration of their stay. Undergraduate students can participate in a 10-week intensive summer session or a full academic year program. In either case, the curriculum focuses on a comprehensive engineering-mentored experience in the student's specific field of study.

32

SBIR submissions, more than three times the school's previous annual number

TRAINING TOMORROW'S ADVANCED MANUFACTURING WORKFORCE

The Samueli School co-hosted a multi-agency workshop last fall with the National Institute of Standards and Technology to examine the nation's progress in advanced manufacturing. Held at the Beckman Center of the National Academies of Sciences and Engineering on the edge of the UCI campus, government agents gathered to hear input from academics and industry experts. UCI is already leading the way in biomedical and additive manufacturing (also known as desktop factories or 3-D printing), which lets users design prototypes on their computers and print them out. The Samueli School's RapidTech center is the only nonprofit on a U.S. campus that trains community college and university students in advanced manufacturing technologies.

SMALL BUSINESS INNOVATION

In a focused research effort, the Samueli School made some strategic moves this year to help faculty grow their funding. Among the efforts was a partnership with OCTANe, a regional innovation network, to present workshops on best methods to obtain small business government grants for innovation research (SBIR) and technology transfer (STTR). The workshops, designed to facilitate alliances between university researchers and private sector entrepreneurs and business people, seem to pay off with 32 SBIR projects submitted, more than three times the school's previous annual number. "The workshops provided a forum for the school to build tangible relationships with industries, transfer our technical innovations into the real world and form partnerships in pursuit of funding opportunities," says William Tang, professor and Samueli School associate dean for research.

100 freshmen complete inaugural experiential learning program

12

entrepreneurial engineering students on winning business plan competition teams

inspiringingenuity

Through an experiential approach, the Samueli School inspires ingenuity by integrating hands-on education with fundamentals and research.

2013 NATIONAL CHAMPIONS

Design, Build, Fly Team

9 graduate from the inaugural Master of Science in Engineering Management program

Giulia Canton, a mechanical and aerospace engineering Ph.D. candidate, holds a 3-D print made from a scan that can be used to create a mold for reproducing her likeness in a variety of materials.

FABRICATING the future

RAPIDTECH TRAINS TOMORROW'S WORKFORCE IN ADVANCED MANUFACTURING TECHNOLOGIES | by Janet Wilson

"We hope to be one of the few universities capable of providing engineers with an understanding of their individual disciplines and, on top of that, who have an understanding of how things are made – literally from doing it themselves – so they can walk into companies and be commercially productive from Day One."

Ed Tackett whirls through the fourth floor of UC Irvine's Engineering Hall, showing off tiny toy figurines, a bright-red leg bone, a waxen skull and more.

"We're just finishing the housing for a 'non-squish' breast cancer detector," he says, looking at freshly painted soft-pink components. Student intern Garritt Ong, looks on, hefting a block of resin to begin a project of his own. "I love it; I'm learning everything about everything," he says enthusiastically.

All of the items on display and hundreds more have been designed on computers and produced via three-dimensional printing at the National Center for Rapid Technologies, or RapidTech, the only nonprofit in the U.S. dedicated to hands-on training of community college and university students in the next wave of advanced manufacturing.

Forget the Industrial Revolution and tool-and-die factory assembly lines. While custom 3-D printers are gaining popularity in home handyman projects, the printers here are industrial-strength, and so is the mission.

It's a campus version of the supply chain of the future, academics and other experts say, and key to bringing full-fledged manufacturing back to this nation. President Obama is seeking $1 billion in next year's federal budget to make the U.S. a world leader in advanced manufacturing.

"This is an extraordinarily exciting time, characterized by many as a third manufacturing revolution. Technologies like additive manufacturing are changing the rules," says Mike Molnar, director of the National Institute of Standards & Technology Advanced Manufacturing Office. "Just as computing evolved from mainframe data centers to personal devices, in the future, if you have an idea, you will be able to make it."

"This is an extraordinarily exciting time, characterized by many as a third manufacturing revolution."

"Having RapidTech on campus is a real plus," says Gregory Washington, Samueli School dean. "We hope to be one of the few universities capable of providing engineers with an understanding of their individual disciplines and, on top of that, who have an understanding of how things are made – literally from doing it themselves – so they can walk into companies and be commercially productive from Day One."

Bringing real-world mechanical engineering shops back to universities and colleges is critical, says mechanical engineering professor Marc Madou, one of the first to sound the alarm on the need for more U.S. engineers capable of producing what they design. About 600,000 manufacturing jobs in the U.S. are currently unfilled.

Above: "After the digital revolution, mechanical engineering shops on campuses fell out of favor," says Chancellor's Professor Marc Madou. "They were considered dirty, lowbrow. Now those attitudes are changing."

"After the digital revolution, mechanical engineering shops on campuses fell out of favor. They were considered dirty, lowbrow. Now those attitudes are changing," says Madou, who teaches an advanced manufacturing class for upper-level undergraduates and graduate students.

In 2005, he co-authored "Micromanufacturing," which looked at the future of manufacturing worldwide. All his students also take a practicum at RapidTech each year, to learn how to turn theories into prototypes and finished products.

Tackett, director of RapidTech, is blunt: "We have advanced engineering students come in who don't know what a Phillips-head screwdriver is."

The facility has more than 20 printers and other large pieces of equipment that help both academia and industry use modern technologies for engineering, biology and even arts projects. RapidTech has already produced everything from medical devices to architectural models to drum sets, as well as servicing such traditional sectors as aerospace and automotive.

Community college and undergraduate students are employed as interns, and UCI doctoral students and researchers come knocking with project designs – as do Boeing, the U.S. Coast Guard, the U.S. Army and hundreds of smaller companies and academic laboratories.

"We're so glad that RapidTech is here. It's just essential to have that kind of fabrication facility at a major university," says Bruce Tromberg, professor of biomedical engineering and director of UCI's Beckman Laser Institute and Medical Clinic. He and fellow researchers have spent more than 20 years working on a laser breast scanner that's less painful than traditional mammography machines and may be far more effective with denser breast tissue.

Once they nailed down the advanced physics principles, they needed to figure out a way to craft a patient-friendly device containing their pioneering laser technology. Tromberg's doctoral students modeled a handheld version out of Play-Doh and walked across campus to RapidTech with it, getting a testable prototype within days instead of months.

Swati Sharma and Giulia Canton, graduate students of Madou's, have been laboring for months on nanoscale carbon wires for biomedical devices that could sense more cheaply and quickly than traditional tests how a drug is metabolizing or whether a disease is present in DNA. For them, Madou's class and RapidTech are vital.

"They help me learn how to do things, not just study them," says Canton.

Above: Ben Dolan, RapidTech engineer, digs out a model created by a 3-D printer from two-dimensional medical imaging files. This additive manufacturing technique provides quick, inexpensive parts for concept modeling.

Left: Prior to RapidTech, a graduate student of Madou's worked hard to develop a CD prototype anthrax detection system. Now similar prototypes can be made quickly and cheaply at the center.

Winged Wonder

FROM A PECULIAR INSECT, A GOOD IDEA EMERGES ABOUT NANOPATTERNED BIOMATERIALS | by Shari Roan

Every 17 years in late spring, they crawl from the moist, cool ground of the Northeastern United States, swarm into the air and fill human ears with their raucous, buzzing chorus. This year marked the return of the weird, winged cicada bug.

But in Albert Yee's materials science lab at UC Irvine, cicada mania was already in full swing. A chance discovery by one of Yee's students in the fall of 2012 triggered a research project on the wonders of the cicada wing and produced findings that may someday lead to better biomedical products. And, by her own admission, Nicole Ing, a second-year graduate student in materials science, doesn't even like bugs.

"We've discovered what good solutions cicadas provide for problems we've been working on for a long time," says Ing. "This project has taught me cicadas are cool."

The project began last year when Yee, a professor and chair of chemical engineering and materials science, directed Ing and third-year biomedical engineering graduate student Elena Liang to study how cells replicate, proliferate or die on nanopatterned surfaces. Ing logged on to her computer to research the topic and encountered an Australian paper describing how cicada wings kill bacteria on contact. Neither Ing nor Liang was well-versed on cicadas, however, and that proved problematic when Yee suggested they go out and find one.

"I caught a bug, and I thought it was a cicada. But I was totally wrong," Liang recounts. Her roommate, who had studied entomology, informed Liang that she was in possession of a run-of-the-mill katydid.

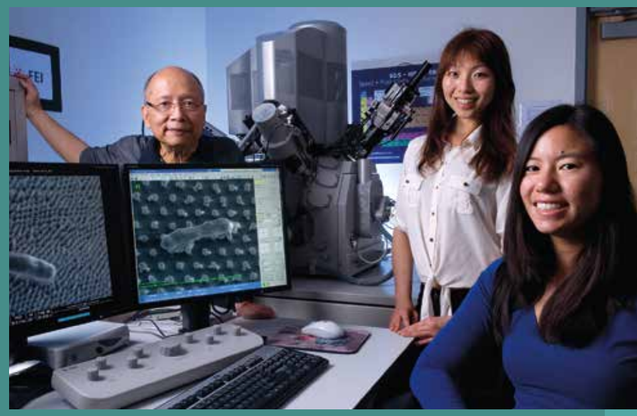
"She is a Southern California girl and didn't know what they looked like," Yee says, with a laugh. "I've seen cicadas, but I didn't know that we don't have them on the West Coast."

In fact, the elusive insects belong to one of several broods that have 13- or 17-year cycles. They emerge in the Northeast when the soil temperature warms to about 64 degrees. The nymphs quickly develop, crawl into trees or structures and then fly around to mate. After the females lay eggs, the adult population dies and the next generation of nymphs hatch and burrow into the ground for a long slumber.

Yee and his students were wise to pay attention to the Australian paper. In recent years, materials scientists have discovered that several types of insects have wings that can serve as templates for designing ultra-clean synthetic surfaces. The cicada wing features a unique nanotopography that sheds water and debris, such as dirt, dust and microbes.

So, armed with a few dead cicadas purchased for $12 each from an online store, Ing and Liang set out to work.

"The cicada has a wing surface that has exactly the nanopatterns we've been working on. It was quite a fabulous serendipity," Yee says of Ing's discovery of the Australian paper. "So that, in part, verified our conjecture that this kind of surface can have very interesting interactions with cells and bacteria."

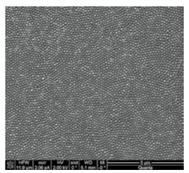


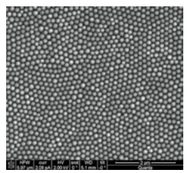
Materials science graduate students Nicole Ing (center) and Elena Liang (right) work with Albert Yee, professor and chair of the chemical engineering and materials science department, on replicating the surface patterns of a cicada wing.

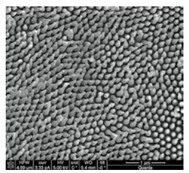
"We want to be able to replicate what we see in nature and find practical uses in the medical world and in research."

"In areas where adhesion is needed, we use a line pattern. In areas where we don't want adhesion, we use a cone pattern."

Yee's students use an extreme high-resolution scanning electron microscope in a UCI microscopy center, considered the most state-of-the-art in Southern California.







Under the microscope, the students could see a bumpy surface consisting of tiny structures shaped like truncated cones. The topography allows water to slip off the wing and keep it clean.

Ing and Liang proceeded to replicate the surface pattern on different polymers. When Ing moved on to work in another lab, Liang continued the research and developed techniques to reproduce the patterns with nanoimprinting. Finally, she tested the surface properties with bacteria, observing what kinds of patterns cause the bacteria to die or to adhere. She found cone patterns cause cell death while line patterns promote adhesion.

"Clearly these bacteria are able to sense their surroundings and change their shapes to conform to the surface they are in contact with," Yee explains.

Creating nanosurfaces with antibacterial properties is a highly sought-after goal in biomedical engineering. While chemicals – antibiotics – can be added to a surface, they often degrade over time or the bacteria become resistant to the drugs. Numerous medical devices could be improved if they could be designed with non-chemical antibacterial surfaces.

For example, Yee is working on an artificial cornea, which is proving to be no simple feat. The product has to be made of a polymer that the body won't reject and yet will resist the natural tendency of epithelial cells in the eye from growing over it.

"There are these conflicting demands: It has to be incorporated into the eye without moving, being rejected or causing inflammation. But it has to remain clear," Yee explains.

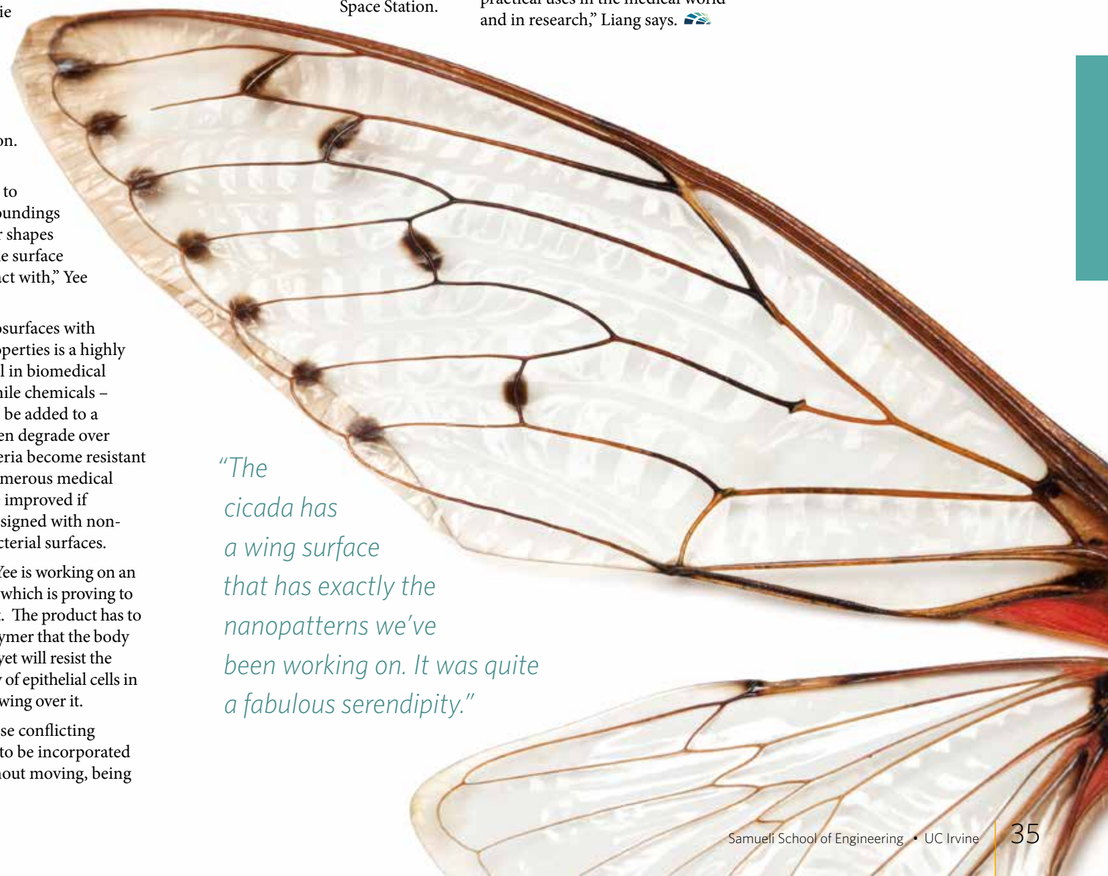
His solution is to create an artificial cornea with a nanopatterned surface. His students' work on the cicada wings demonstrates its feasibility.

"In areas where adhesion is needed, we use a line pattern. In areas where we don't want adhesion, we use a cone pattern," he explains.

Ing has also proposed that cicada-inspired nanosurfaces could be used by NASA to tackle the problem of bacterial growth on the International Space Station. In such a closed environment, bacteria can flourish, sickening astronauts and causing equipment failure. "But," she says, "if the structure itself can kill bacteria without any chemicals, that would be ideal."

Both Ing and Liang say the cicada project has given them a new respect for nature and the field of biomimetics – the study of biological structures and systems as templates for engineering man-made goods.

"We want to be able to replicate what we see in nature and find practical uses in the medical world and in research," Liang says.



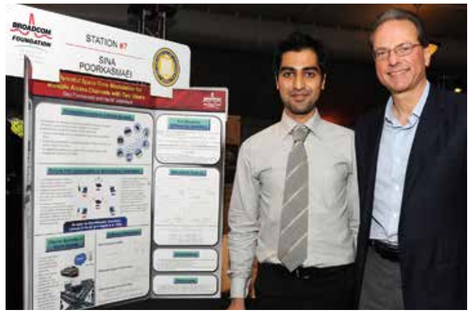
"The cicada has a wing surface that has exactly the nanopatterns we've been working on. It was quite a fabulous serendipity."

SOARING TO THE TOP

Samueli School students won first place at the 17th annual American Institute of Aeronautics and Astronautics (AIAA) Foundation Design/Build/Fly (DBF) competition in Arizona. "We expected to place in the top 10, given our preparation and effort," says John Wei-Han Chen, senior engineering student and DBF project manager. "It definitely felt good to see all of our hard work coming together. We were extremely happy to win first place for UCI." The national competition provides students an opportunity to design and build a radio-controlled aircraft to perform specific missions. This year's design assignment was a simulation of a Joint Strike Fighter aircraft with three missions: speed/endurance, stealth and strike. UCI's 31-person team spent eight months on design fabrication and flight testing, and they soared to victory over 80 other college teams.

30

Samueli School student engineering organizations



A BROADCOM FOUNDATION RESEARCH FINALIST

An electrical engineering and computer science graduate student was among 12 finalists from one dozen universities around the world competing in Broadcom Foundation's University Research Competition. Sina Poorkasmaei worked with Chancellor's Professor Hamid Jafarkhani on his project, which studied the technical challenges posed by improving the quality of information exchange between portable devices. The finalists were chosen by a select committee comprised of preeminent engineers. The competition is spearheaded by Broadcom's co-founder, Henry Samueli, distinguished adjunct professor, and celebrates academic excellence and social awareness among students who perform extraordinary academic research.

AN ENGINEERING AND BUSINESS SCHOOL PARTNERSHIP

The inaugural class of the UCI Master of Science in Engineering Management degree program graduated in June. Nine students completed the program, which prepares engineers for leadership roles in industry, government, science and technology organizations as well as entrepreneurial ventures. The intensive one-year program integrates the extensive resources and networks of the Paul Merage School of Business and the Samueli School. Working together, these schools provide the cutting-edge engineering skills and proven, real-world business practices that engineers need to become effective leaders and industry innovators. "As an engineer, I also wanted to be proficient on the business side, learn to communicate with accountants, marketers and other business people," says Kevin Leong, one of the graduates. "It's been a great experience. I've learned so much and there's a great sense of community."

HANDS-ON ENGINEERING FROM THE START

The Samueli School's new freshman experiential learning course – a first of its kind in the UC system – proved successful in giving first-year students a hands-on engineering experience. Participants designed, built and tested a multidisciplinary project: a remote control hovercraft in the fall and an autonomous hovercraft in the winter. The course introduces students to the various engineering disciplines and culminates with a heated hovercraft competition. Says Nina Tamashiro, leader of the winning team, "I really enjoyed being able to work with tools, and I saw the importance of teamwork. The hovercraft was a product of our collaboration. We were given a deadline and the essential tools needed. The rest was up to us."

BUDDING ENTREPRENEURS REWARDED

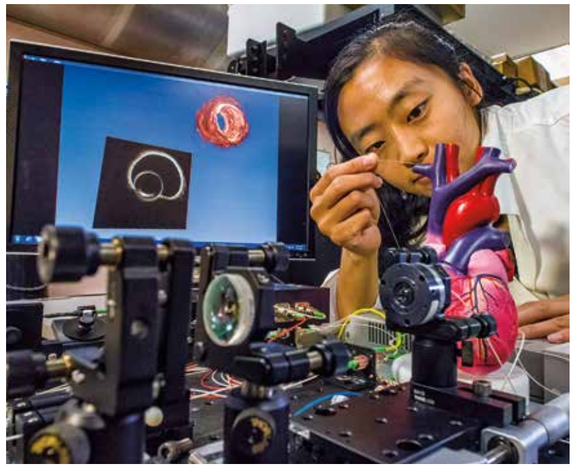
Student engineers put their entrepreneurial skills on the line in business competitions this past year. They fared well in UCI's Paul Merage School's 2013 Business Plan Competition. Of the 19 teams that competed in the final leg of the annual competition, seven teams won awards and six included one or more engineering students. In another show of business acumen, biomedical engineering student Michelle Sangalang's team brought home the grand prize in their age category in the statewide Youth Entrepreneurship Program's Boost Business Plan Competition, with a customized manual wheelchair that uses an advanced propulsion lever system.

NEWEST ANTEATER ENGINEERS: ZOT! ZOT!

This past spring, the Samueli School graduated its largest class of engineers to date, awarding 541 bachelor's degrees, 265 master's degrees and 92 doctorates. On a faculty-per-doctoral-student-ratio, 92 Ph.D.s puts the Samueli School in the top 10 engineering graduate programs in the country. The Class of 2013 is among the most competitive and is workforce ready, having participated in faculty-mentored research and hands-on engineering projects. The school's focus on experiential learning is having a tremendous impact on attracting and retaining students, and the number of student projects, research experiences and internships has more than doubled over the past year. This fall, the school will welcome the largest and smartest class of Anteater Engineers in the school's history.

265

master's degrees,
115 MORE
than last year



THE BEST PROGRAM FOR BIOPHOTONICS

A UCI professor of biomedical engineering, and chemical engineering and materials science is leading a new interdisciplinary graduate program in biophotonics, the development and application of optical technologies to advance biomedical science and healthcare. Vasan Venugopalan received a five-year, $3 million Integrative Graduate Education and Research Traineeship (IGERT) grant from the National Science Foundation to create a doctoral-level program that integrates physics, chemistry, engineering and the life sciences. "UCI is a long-standing international leader in biophotonics," says Venugopalan, who also is affiliated with UCI's Beckman Laser Institute. "IGERT support enables us to build a new model for graduate biophotonics education in the U.S. It will establish strong interdisciplinary interactions at the earliest stages of the graduate student experience and provide opportunities for closer integration and collaboration across research disciplines." As many as six new students will be enrolled annually into the Biophotonics Across Energy, Space and Time (BEST) program.

FEDERAL AGENCIES SUPPORT GRAD STUDENT RESEARCH

Several federal agencies recognized graduate students with prestigious research awards this past year. The NSF granted Graduate Research Fellowships to five Samueli School students: Julius Edson, Dominique Ingato and Nicole Ing in chemical engineering and materials science; Daniel Howard in the Advanced Power and Energy Program; and Tim Smith in biomedical engineering. The NSF also awarded funding for three students to attend summer institutes in Japan: Jesse Angle, in materials science, Seema Ehsan in chemical engineering, and Aggie Szymanska in biomedical engineering. The Department of Defense awarded civil and environmental engineering doctoral student Andrea Thorstensen a National Defense Science and Engineering Graduate Fellowship. Finally, two civil and environmental engineering graduate students – Hamed Ashouri and Scott Sellars – earned NASA Earth and Space Science Fellowship Awards for their research projects.

STUDYING WATER SUSTAINABILITY IN AUSTRALIA

Twelve undergraduate students participated in a six-week research experience, which included two weeks in Australia. While there, students traveled to multiple sites to collect water samples and spent long hours in a University of Melbourne lab learning water analysis techniques. Upon returning to UCI, they continued their analysis and then presented the findings at a mini-symposium. The summer course is part of the UCI Water-Partnerships for International Research and Education (PIRE) project, spearheaded by Samueli School civil and environmental engineer Stan Grant. The UCI Water-PIRE is an NSF-funded collaboration between Australian and a trio of Southern California universities to study the technologies and policies implemented during the Millennium Drought and its aftermath. The goal is to find low-energy methods of turning wastewater into drinking water.

BROADCOM FOUNDATION FUNDS GRADUATE FELLOWSHIPS

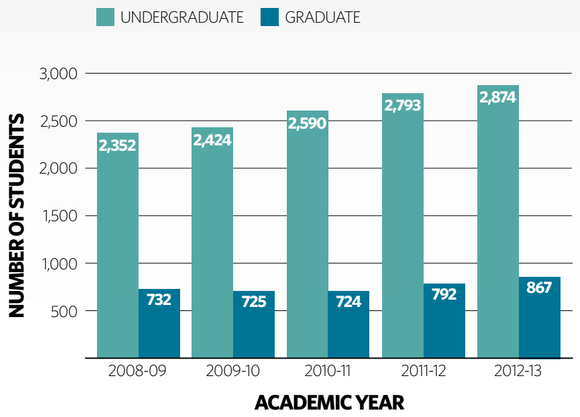
The Broadcom Foundation has established four graduate fellowships at the Samueli School to support students interested in doing interdisciplinary research aimed at enhancing the communications ability of mobile devices. The $400,000 gift funds four electrical engineering graduate students each year for the next two years. "The Broadcom Fellowship helps us not only recruit the top talented students in the communications field, but it also allows us to focus on innovations for the future," says G.P. Li, UCI professor of electrical engineering and computer science, who will administer the program. Students selected for the fellowship will conduct research that integrates the disciplines of electrical engineering and computer science to promote a broader approach to meeting the future challenges in a hyper-connected world.

GIVING BACK TO HIS HISPANIC ROOTS PAYS OFF

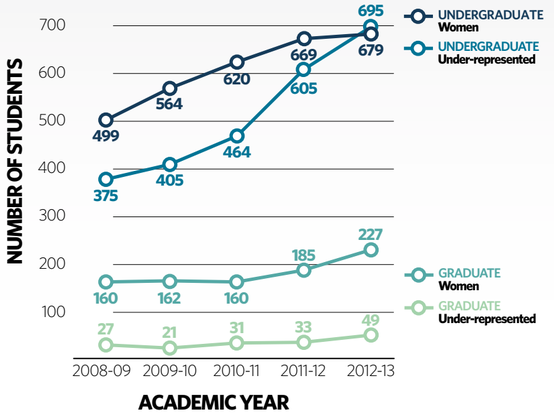
Civil engineering student Abraham Baca was named a 2012 scholarship recipient by the Hispanic Engineer National Achievement Awards Corporation-Southern California Edison. Abraham has traveled a long road from Mexico to UCI. He is the first in his family to attend college. As a freshman, Baca sought out and joined the Latino Business Student Association. The only STEM student in the organization, he continued to be involved through his senior year when he was elected president. As president, he re-engaged community service opportunities for the organization. He also instilled a mentorship program. As part of another program sponsored through the California Hispanic Chamber of Commerce, Baca and his group successfully raised $12,000 for much-needed supplies for a local elementary school in the Hispanic community.

AT A **GLANCE**

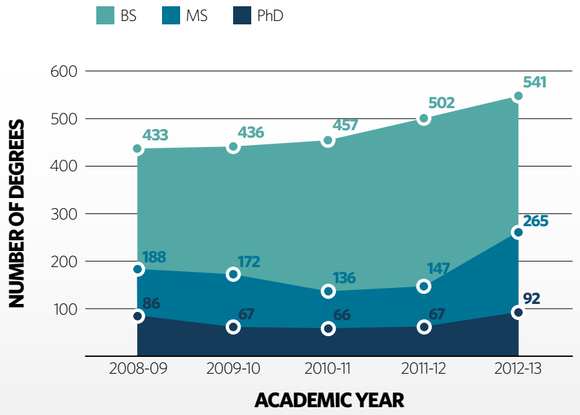
STUDENT**ENROLLMENT**



STUDENT**DIVERSITY**



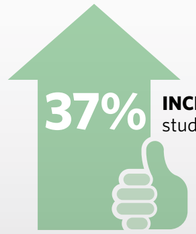
DEGREES**GRANTED**



UNDER-REPRESENTED**STUDENTS**

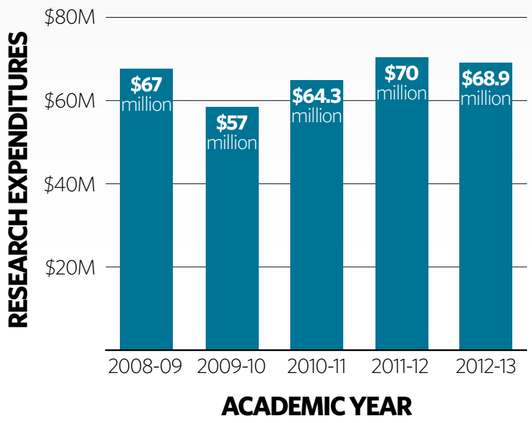
INCREASE in total under-represented students over the past five years

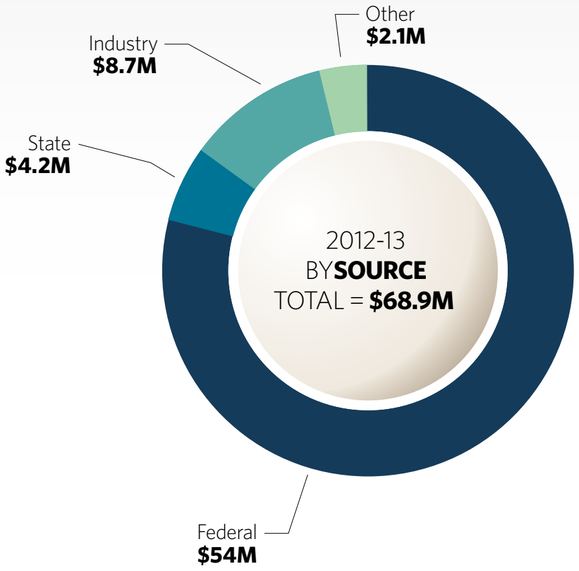
FEMALE**STUDENTS**



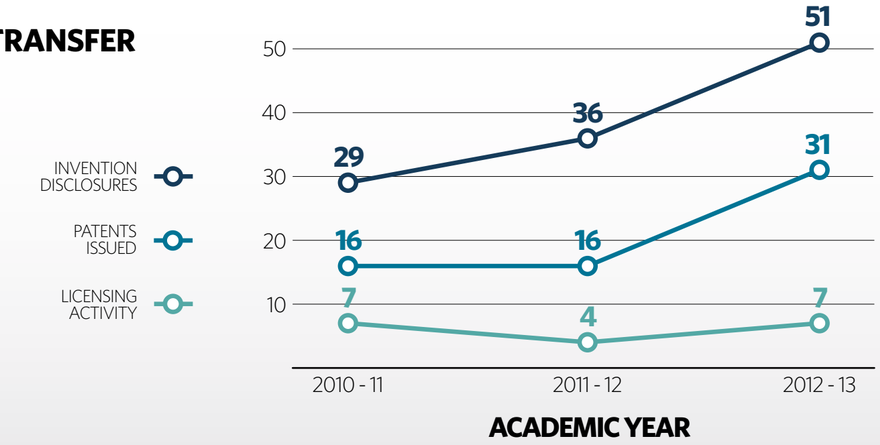
INCREASE in total female students over the past five years

RESEARCH**EXPENDITURES**

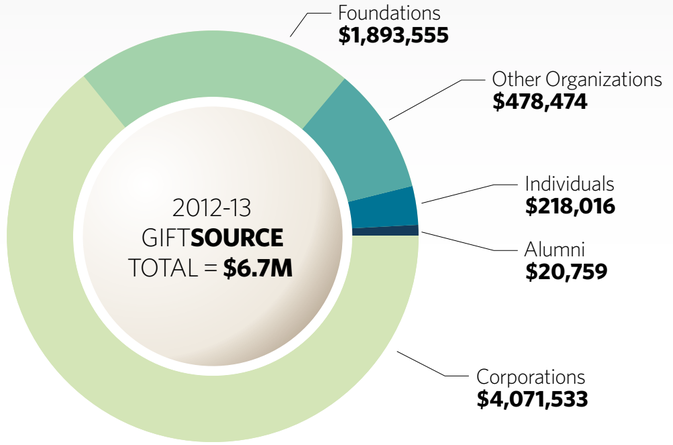


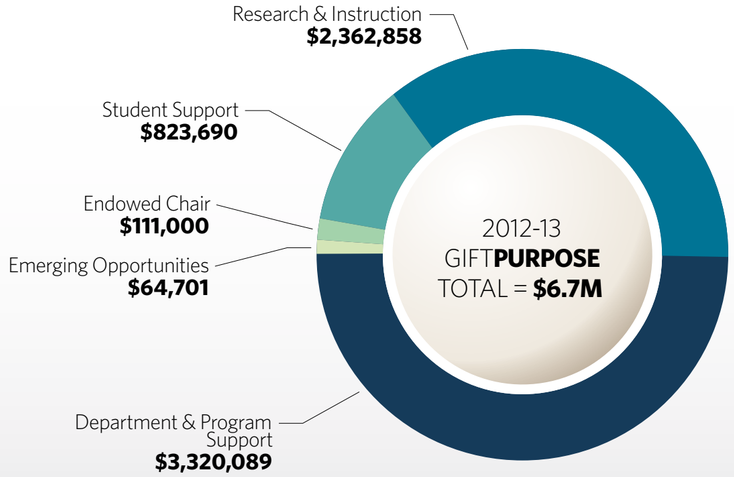


TECHNOLOGY**TRANSFER**



DONOR**SUPPORT**

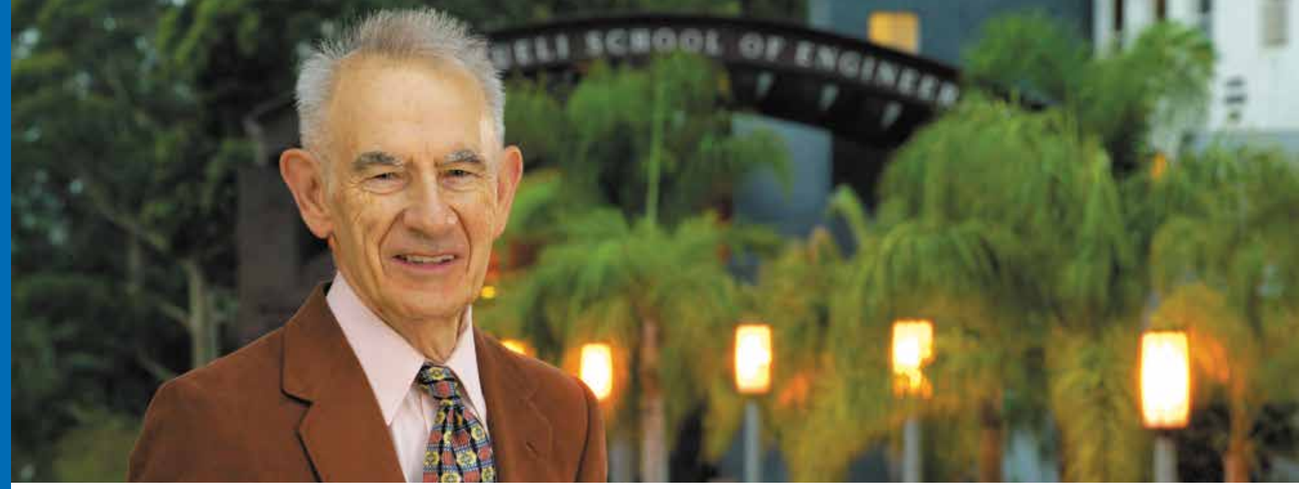




BUILDING TOWERS

FELLOWSHIP PROGRAM BRINGS CATALAN ENGINEERING STUDENTS TO THE SAMUELI SCHOOL | by Lori Brandt

The people of Catalonia, Spain, have a centuries-old cultural tradition of building human towers, or castells (castles). Usually seen at festivals or competitions, the castellers climb up each other and stand on their countrymen's shoulders to construct a tower that can reach 10 human-stories high, often with a child on top. A crowd surrounds them, providing the safety net.



Successful engineer and Catalan native Peter J. Balsells is creating another sort of human tower, one of opportunity, right here at UC Irvine. In 1995, he endowed the Balsells-Generalitat Fellowship program in the Samueli School of Engineering. Since then, nearly 100 of the most talented young engineers and scientists from Catalonia have come to UCI to pursue graduate studies and conduct research in engineering.

"I really had to struggle, so I wanted to help others get the best education possible," says Balsells, who overcame great hardship while growing up in Spain during the oppressive Franco regime. His aunt provided him with a unique opportunity to pursue an engineering education in the U.S. He went on to excel in his studies and subsequent career. Today, Balsells is a successful engineer who holds 120 patents worldwide and is founder and chairman of Bal Seal Engineering.

Roger Rangel, professor of mechanical and aerospace engineering and Balsells Fellowship Program director, believes it is the most successful fellowship program at the university. "We host about 20 students a year, all highly qualified," Rangel explains. "These fellows conduct research, publish papers and help obtain grant funds. It's a very competitive program that receives additional support from the Catalan government."

Eight new students arrive each fall for a one- or two-year fellowship. A third of them stays and pursues doctoral degrees. The Catalans already here help orient the newest arrivals, all building upon the foundation established by Balsells.

David Escofet Martin is among the most recent group of Fellows. He is working on a master's degree in mechanical and aerospace engineering and conducting research that involves laser diagnostic techniques and fluid mechanics. He's also an excellent chess player and holds the title of Catalan Chess Master. Since moving to California, he's learned to surf, leaving less time for chess. But what he misses most about his home country is the food. "I especially miss the Pernil Salat," he explains, about the traditional specialty of dry-cured Spanish ham that he often ate with bread at his home in Rubi, Spain.

Alba Alfonso Garcia is in her second year at the Samueli School. She is pursuing a doctoral degree in biomedical engineering and conducts research in biomedical photonics and bio-imaging. "I like the research opportunities at UCI," she says. "In Europe there is more specialization. Here, there are more resources and collaboration; it is enriching and mind-opening."

Sergio de Miguel, one of the first Balsells Fellows in 1996, says the experience was a cornerstone in his career. After earning a master's degree in mechanical and aerospace engineering, de Miguel went to work for Honeywell in Arizona and in France, where he met his future wife. He returned to Catalonia to help with the family business and today is general manager and co-owner of Gometrics, a leading instrumentation and calibration equipment services company.

Many of the fellows have gone on to careers in business, government, research and academia in the U.S., back home in Spain and in other places in Europe and around the world.

"For me, the Balsells Fellowship was a door to a more interesting career," says Alba Perez Gracia, a Balsells Fellow from 1997. "I was a bored engineer working in the automotive industry in Spain, and today I am a university professor in the U.S. working in robotics." Perez Gracia is an associate professor of mechanical engineering at Idaho State University.

Through his initial endowment, Balsells has provided the shoulders for many of his countrymen and women to stand on. His castle has benefited the Samueli School as well as Catalonia.

Above: For his many years of outstanding commitment and generous support to the Samueli School, Pete Balsells is recognized with the school's first annual Ingenuity Award. He is surrounded by the current Balsells Fellows and program director Professor Roger Rangel.

THE SAMUELI SCHOOL DIFFERENCE

We believe in meeting tomorrow's technological challenges by providing the highest quality engineering education and research rigor today. Private contributions are critical to the school's success. We need the support and involvement of our community, alumni and friends to continue our progress.

This fall, the school will welcome the largest and smartest class of Anteater Engineers in the school's history. More than a third of this class is identified as low income. For many students, a UCI education will change their family's future.

With a commitment to quality education, the Dean's Circle will support curriculum development, enhanced educational environments and experiential learning. Your annual gift of $1,000 or more ($250 for alumni who have graduated within the last five years) ensures the tradition of excellence known to all Anteater Engineers, and will continue to prepare the engineering leaders and innovators of tomorrow.

MEMBERSHIP BENEFITS INCLUDE:

- Satisfaction that your tax-deductible gift directly impacts students and faculty
- Early notification of Samueli School events – including receptions, reunions, lectures and seminars
- Invitation to annual VIP event with the Dean
- Recognition through online Dean's Circle Honor Roll

YOUR GIFT WILL SUPPORT:

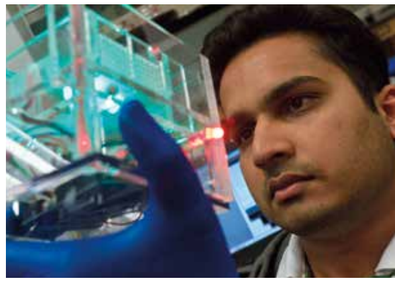
- Scholarships and fellowships that help offset the high costs of a university education, and help recruit and support the best and brightest students
- Exciting research and training opportunities with world-renowned researchers
- Critical academic programs, novel research, senior design projects and other valuable initiatives
- Annual programs such as the student council's E-Week Celebration and EngiTECH Career Fair
- Cutting-edge facilities for students and faculty

Join the Dean's Circle by making a commitment with the attached envelope or contact the school's external relations department at (949) 824-8546.

Your contribution, regardless of amount, makes a difference toward what the school can accomplish. Thank you for your dedication and support of UCI's Samueli School of Engineering!

37%
of our engineering freshmen are from low-income families

56%
of our engineering freshmen are first-generation students



83%
of our students demonstrate a specific financial need

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