ENGINEERING SOLUTIONS FOR GLOBAL GRAND CHALLENGES

UCI Samueli
School of Engineering

University of California, Irvine

2016-17 DEAN'S REPORT

CONTENTS

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University of California, Irvine

2016-17 DEAN'S REPORT

The award-winning *Dean's Report* is published annually in early fall by the Samueli School's Communications Department.

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FROM THE DEAN

PRIORITIES FOR IMPACTFUL DISCOVERY AND INNOVATION

We are at a critical moment in the history of the Samueli School of Engineering. UC Irvine is under a mandate to grow and plans a major buildout over the next decade. Our engineering school plays a vital role in this expansion. A generous $30 million Samueli Foundation gift toward the construction of a 180,000-square-foot interdisciplinary science and engineering building is a significant milestone in this effort. With the additional space, we will build upon our distinctive Anteater engineering experience to ensure all students have the knowledge, skills and leadership to tackle today's global grand challenges.

This year we launched the school's 2025 Strategic Plan as our roadmap for excellence, and the true strength of our future resides in human connections. These connections instill collaboration across disciplines. Together, we are addressing societal needs, such as water and energy sustainability, accessible health care, and new materials and technology development. By engineering novel solutions for these challenges, we are poised to influence economic growth, create job opportunities and promote prosperity.

Within the plan, we have identified four priorities that will drive the UCI engineering program's excellence and growth in the 21st century:

- Harness engineering innovation for a climate-resilient, thriving California
- Lead the new industrial revolution in technology and manufacturing
- Advance human well-being by way of a holistic, affordable approach
- Provide thought leadership in engineering education and outreach

Our faculty continue to pursue groundbreaking research that is timely and impactful, addressing today's global complexities. This past year, in an international study led by UCI environmental engineers, researchers forecasted large increases in the frequency and intensity of extreme weather events, including killer heatwaves. The headline-grabbing findings brought heightened awareness to the dangers of climate change and the need for novel approaches.

The Samueli School is a key player in two U.S. Department of Energy large-scale, multi-institute efforts. Professor Julie Schoenung is heading UCI's role in the REMADE Institute, whose goal is to forge new clean-energy initiatives critical in keeping the nation's manufacturing on the cutting edge. Under the leadership of Professor G.P. Li, the campus serves as the Southern California demonstration site for the Clean Energy Smart Manufacturing Institute. Combined, the efforts total more than $280 million in public-private investment focused on improving energy productivity and creating new jobs in U.S. manufacturing.

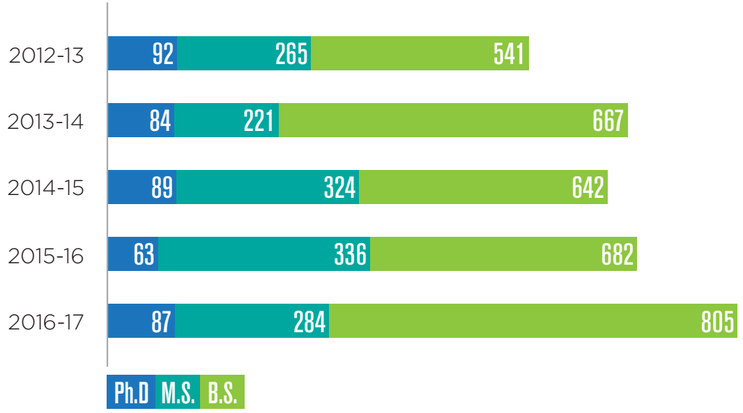
The school's emphasis on experiential learning is attracting high-achieving students who want more than a classroom experience. We are excited about our new Moonshot Initiative, a hands-on program that intends to make UCI the first academic institution to launch a liquid-fuel rocket into space. Thanks to a $1 million gift from Base 11, the program will include a mobile rocket lab for transporting prototypes to test sites and making off-site repairs.

With the strategic plan in place, our aspirations will inspire and encourage Samueli School faculty, students and partners to join in the pursuit of engineering solutions for global grand challenges.

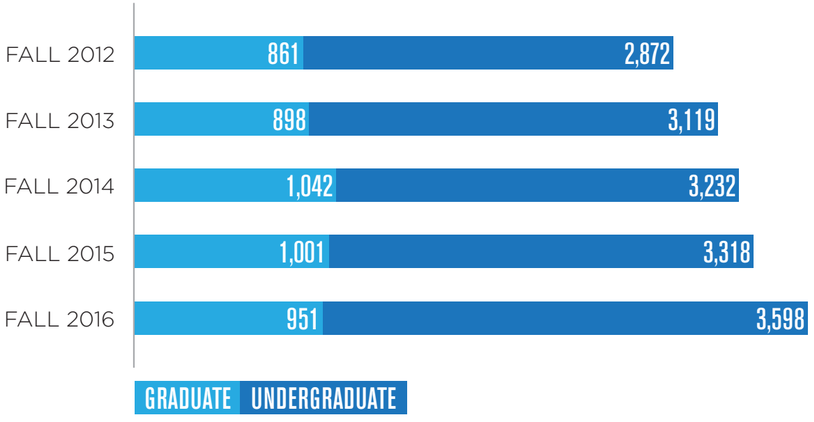
Gregory Washington, Ph.D.
Stacey Nicholas Dean of Engineering

QUALITY INDICATORS

DEGREES GRANTED



STUDENT ENROLLMENT



UNDERGRADUATE STUDENTS FALL 2016 BY DEPARTMENT

448 BIOMEDICAL

407 CHEMICAL & MATERIALS SCIENCE

463 CIVIL & ENVIRONMENTAL

1,059 ELECTRICAL & COMPUTER SCIENCE

1,096 MECHANICAL & AEROSPACE

INCOMING FRESHMEN

39% FIRST-GENERATION COLLEGE STUDENTS

27% FROM LOW-INCOME FAMILIES

4.09 AVERAGE GPA

1,980 AVERAGE SAT

STUDENT DIVERSITY

865 FEMALE UNDERGRADUATES — **28%** INCREASE OVER 5 YEARS

955 UNDERREPRESENTED UNDERGRADUATES — **38%** INCREASE OVER 5 YEARS

302 FEMALE GRADUATE STUDENTS — **35%** INCREASE OVER 5 YEARS

42 UNDERREPRESENTED GRADUATE STUDENTS — **-14%** DECREASE OVER 5 YEARS

GRADUATE STUDENTS FALL 2016 BY DEPARTMENT

120 BIOMEDICAL

174 CHEMICAL & MATERIALS SCIENCE

170 CIVIL & ENVIRONMENTAL

327 ELECTRICAL & COMPUTER SCIENCE

145 MECHANICAL & AEROSPACE

FACULTY GROWTH

FALL 2013	116
FALL 2014	117
FALL 2015	128
FALL 2016	131
FALL 2017	132

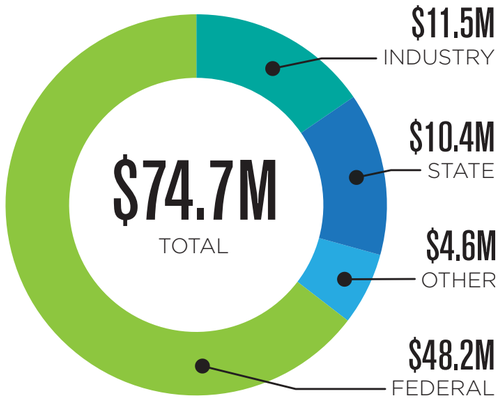
U.S. NEWS & WORLD REPORT ENGINEERING PROGRAM RANKINGS

21st PUBLIC UNIVERSITY GRADUATE

27th PUBLIC UNIVERSITY UNDERGRADUATE

QUALITY INDICATORS

RESEARCH EXPENDITURES
2015-16 BY SOURCE



TOP RESEARCH AWARDS
FOR 2015-16

$2,371,500

NATIONAL INSTITUTES OF HEALTH

"A High-throughput Continuous Evolution System for in vivo Biosensor Engineering"
Chang Liu, assistant professor, biomedical engineering

$1,024,992

NATIONAL SCIENCE FOUNDATION

"DMREF: Engineering Strength and Toughness into Metals"
Enrique Lavernia, provost and professor, chemical engineering and materials science

$1,500,000

STATE OF CALIFORNIA CONSERVATION DEVELOPMENT COMMISSION

"Huntington Beach Advanced Energy Community Blueprint"
Jack Brouwer, associate professor and associate director, Advanced Power and Energy Program

RESEARCH EXPENDITURES
2015-16 BY DEPARTMENT

$34.6M
BIOMEDICAL

$5.7M
CHEMICAL & MATERIALS SCIENCE

$12.3M
CIVIL & ENVIRONMENTAL

$10.4M
ELECTRICAL & COMPUTER SCIENCE

$10.9M
MECHANICAL & AEROSPACE

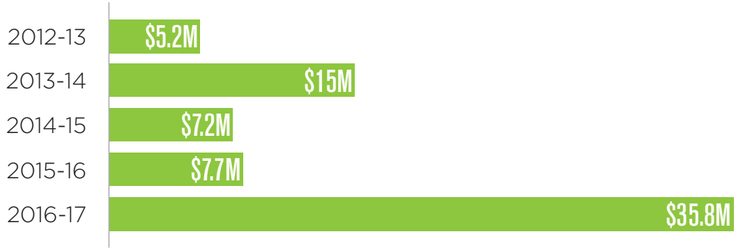
TECHNOLOGY TRANSFER
2016-17

43
INVENTION DISCLOSURES

24
PATENTS

9
LICENSING ACTIVITY

DONOR SUPPORT CASH DONATIONS RECEIVED



GIFT SOURCE 2016-17

$31,705,592	FOUNDATIONS
$3,671,502	CORPORATIONS
$208,000	OTHER ORGANIZATIONS
$185,335	INDIVIDUALS
$75,186	ALUMNI

GIFT PURPOSE 2016-17

$30,008,975	EMERGING OPPORTUNITIES
$3,893,359	DEPARTMENT AND PROGRAM SUPPORT
$1,523,408	RESEARCH AND INSTRUCTION
$419,873	STUDENT SUPPORT

LEADERSHIP COUNCIL

The Samueli School of Engineering Dean's Leadership Council is a distinguished group of thought leaders whose industry expertise, community engagement and entrepreneurial endeavors support, inspire and promote the school's vision.

Nicolaos G. Alexopoulos
Broadcom Ltd.

Tom Ambrose
Broadcom Ltd.

James Aralis
Microsemi Corp.

Don R. Beall
Rockwell

Ken Beall
Rockwell

Roger Brum
Meggitt Defense Systems, Inc.

Bill Carpou
OCTANe

Ray Chan
K5 Ventures

Dan Cregg
Insteon

Mark T. Czaja
Parker Hannifin Corp.

Feyzi Fatehi
Corent Technology, Inc.

Bruce Feuchter
Stradling Yocca Carlson & Rauth

Dominic Gallello
MSC Software

Nabeel Gareeb
The Gareeb Family Foundation

Judy Greenspon
NPI Services, Inc.

Jai Hakhu
Horiba International Corp.

Raouf Y. Halim
Spectra7 Microsystems

Bernard Harguindeguy
Atlantis Computing, Inc.

J.D. Harriman
Arent Fox

Michel R. Kamel
MelRok, LLC

Joe Kiani
Masimo

Scott Kitcher
Sustain OC

Robert A. Kleist
Printronix, Inc.

John Labib
John Labib + Associates

William J. Link
Versant Ventures

Ivan Madera
MORF3D

James Mulato
Astronics Test Systems

Michael A. Mussallem
Edwards Lifesciences Corp.

Stacey Nicholas
Opus Foundation

Al Pedroza
The Boeing Company

Daryl G. Pelc
The Boeing Company

Robert J. Phillippy
Newport Corp.

Jane E. Rady
Abbott Medical Optics, Inc.

Leila Rohani
Pacific Mercantile Bank

Stanton J. Rowe
Edwards Lifesciences Corp.

Henry Samueli
Broadcom Ltd.

Fred Schreiner
Thales Avionics, Inc.

Amit Shah
Artiman Ventures

Paul N. Singarella
Latham & Watkins, LLP

Gerald R. Solomon
The Samueli Foundation

James P. Spoto
Integra Devices

Richard Sudek
UCI Applied Innovation

Landon Taylor
Base 11

Vincent L. Thomas
Rockwell Collins

Maria Tirabassi
Northrup Grumman Aerospace Systems

John J. Tracy
The Boeing Company

Derrick Waters
UPS

James Watson
CMTC

Larry Williams
ANSYS

Ruben Zadoyan
MKS Instruments

ENCORE

From award-winning students and community partnerships to novel research advances and empowering apps, take a fresh look at the past year's significant Samueli School news that bears repeating.

UNDERGRADS SHOW OFF PROTOTYPE AT SPACEX HYPERLOOP COMPETITION

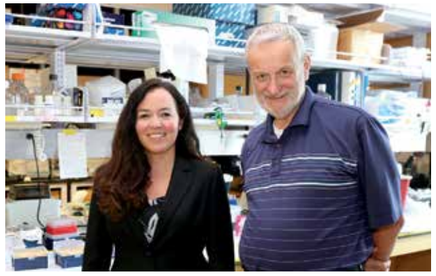
A team of engineering undergraduates put up its sleek, high-tech HyperXite pod vehicle against 27 other entries from around the world at the Hyperloop Pod Competition, held last January at SpaceX headquarters in Hawthorne, Calif. HyperXite placed fifth in an earlier design contest, making it eligible to enter an actual prototype at the competition. Next up, the team will take part in the speed-centered portion of the second competition.

MICROSEMI GIFT CREATES PRESIDENTIAL CHAIR IN ELECTRICAL ENGINEERING

A generous donation from a global semiconductor company will create the UCI Microsemi Presidential Chair in Electrical Engineering. Microsemi's $1.5 million gift combined with $500,000 from the UC Office of the President will establish the new $2 million endowment and support a recognized expert in electrical engineering, as well as research and teaching, equipment and laboratory setup, graduate fellowships and more. "Microsemi is a great partner," said Gregory Washington, the Stacey Nicholas Dean of Engineering at UCI. "This gift will help us recruit the highest quality faculty to be part of one of the most dynamic programs in the nation."

"Microsemi relies upon UCI students and graduates to enhance our team with top engineers, scientists and innovators," said James J. Peterson, the company's chairman and CEO.

Microsemi®
Power Matters.™

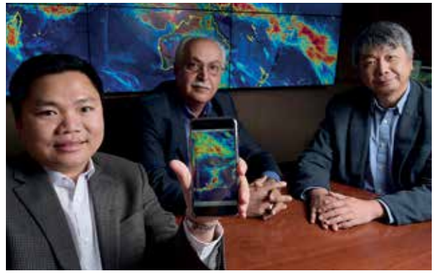


LAB CELEBRATES 30 YEARS OF NIH FUNDING

The Laboratory for Fluorescence Dynamics received a five-year, $7.2 million operating grant from the National Institutes of Health. This marks the 30th year of NIH funding for the lab, the country's only national research center dedicated to fluorescence. The lab, led by biomedical engineers Enrico Gratton and Michelle Digman, has developed new microscopy methods to detect molecular aggregates and the movements of single-protein molecules in live cells and tissue samples.

$1 MILLION GIFT LAUNCHES MOONSHOT INITIATIVE

Students will "shoot for the moon" thanks to a $1 million gift from Base 11, a nonprofit STEM workforce development and entrepreneur accelerator. The Moonshot Initiative bolsters a rocketry program at the Samueli School, with the intent of making UCI the first academic institution to launch a liquid-fuel rocket into space. The Base 11 donation will turn Engineering Tower's ground floor into a rocketry lab that enables students to design, build and test rocket prototypes between 15 and 50 feet long. It will also fund a mobile operations center and assembly trailer that can transport rockets to test sites.



RAIN DATA USED BY AGENCIES WORLDWIDE ARE NOW FREELY AVAILABLE

Faculty members Phu Nguyen, Soroosh Sorooshian and Kuo-lin Hsu created mobile phone app iRain, which provides timely satellite rain data via UCI's globally recognized weather-tracking and analysis system iRain allows users to enter their own rainfall or snowfall observations to join a globe-spanning cadre of citizen hydrologists.

GRAD STUDENT EARNS HIGHLY COMPETITIVE INTERNATIONAL AWARD

David Ordinario is one of only 120 recipients of a postdoctoral fellowship from the Japan Society for the Promotion of Science. Ordinario, who is creating an ultra-flexible ionic e-skin that can facilitate direct communication between biological systems and electronics, will work for two years at the University of Tokyo with Takao Someya, a world-renowned flexible electronics expert.

HIGH SCHOOL STEM COLLABORATION FORMALIZED WITH MOU

The Samueli School of Engineering has signed a memorandum of understanding with the Samueli Academy, a four-year-old Santa Ana charter high school that aims to provide a transformational learning environment to the community's underserved and foster teens. "UCI has helped us in a number of ways," said Samueli Academy engineering teacher Nino Polizzi. The Samueli School has been working with the academy on project-based learning curricula and academic exchanges. "UCI students come on a regular basis after school to help our students with chemistry, engineering, math and in particular, with SolidWorks in our CAD Lab." The MOU will take the relationship further by formalizing it and encouraging matriculation to UCI.

STUDENT RECOGNITION:

Erik Werner was named the first recipient of the SLAS Graduate Education Fellowship Grant by the Society for Laboratory Automation and Screening.

Undergraduate Will Amos was selected as one of six national winners of the 2016 Brower Youth Award.

Maryam Asghari and Anthony Lopez earned Graduate Research Fellowship Awards from the National Science Foundation.

Dominique Ingato received this year's Fletcher Jones Foundation Fellowship, which is awarded to only one UCI doctoral candidate per year.

Graduate student Sumner Norman was one of four UCI students named 2017 Public Impact Distinguished Fellows.

FACULTY SHOUTOUTS:

Professor Donald Dabdub was inducted as an American Association of Aerosol Research fellow.

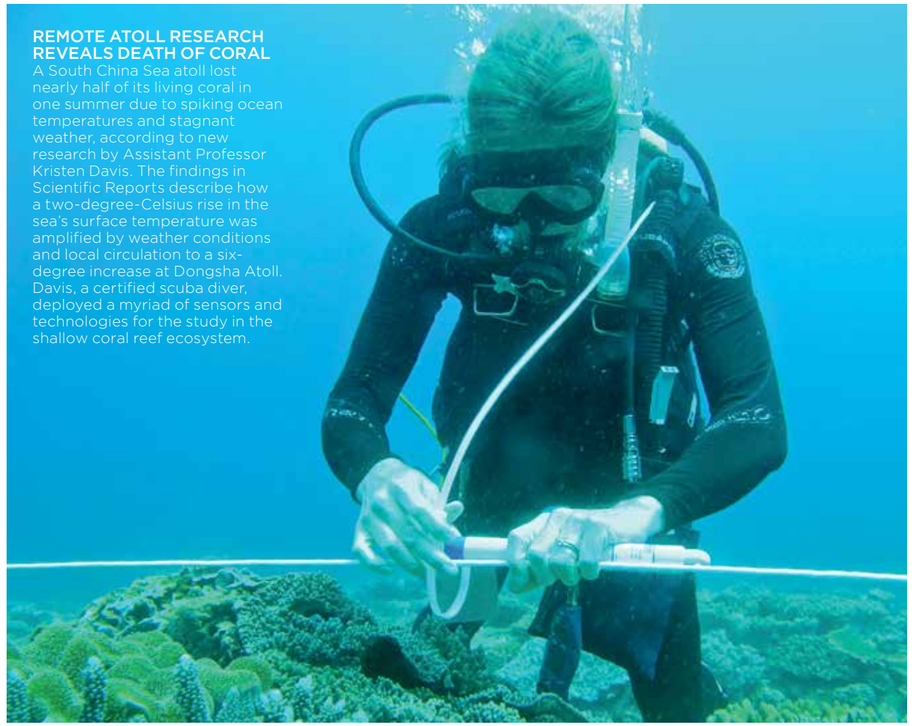
Associate Professor Arash Kheradvar received a Humboldt Fellowship for Experienced Researchers.

Professor Julie Schoenung was elected a fellow of the Alpha Sigma Mu International Professional Honor Society.

Professor Abraham Lee was appointed to a four-year term as editor-in-chief for Lab on a Chip journal.

Professor Andrei Shkel was voted 2018 president-elect of the IEEE Sensors Council, which has more than 260,000 members worldwide.

Associate Professor Zoran Nenadic was appointed a Hai-Tian (Sea-Sky) Scholar by the Dalian University of Technology, China.



REMOTE ATOLL RESEARCH REVEALS DEATH OF CORAL

A South China Sea atoll lost nearly half of its living coral in one summer due to spiking ocean temperatures and stagnant weather, according to new research by Assistant Professor Kristen Davis. The findings in Scientific Reports describe how a two-degree-Celsius rise in the sea's surface temperature was amplified by weather conditions and local circulation to a six-degree increase at Dongsha Atoll. Davis, a certified scuba diver, deployed a myriad of sensors and technologies for the study in the shallow coral reef ecosystem.

TACKLING GRAND CHALLENGES IN WIRELESS COMMUNICATION AND ACCESS

Chancellor's Professor Hamid Jafarkhani is part of a four-institution team awarded a $1.2 million NSF grant for its efforts to enhance the public's access to the radio frequency spectrum — the part of the electromagnetic spectrum used to facilitate telecommunications and modern information systems essential for public safety, transportation and national defense.

DESIGNING AN ENERGY-EFFICIENT CEMENT

Two engineering assistant professors, Mohammad Javad Abdolhosseini Qomi and Jaeho Lee, think they've found a way to manipulate the most commonly used building material in the world – cement – to make it less of an energy drain while not compromising its superior strength. Their findings were published in the January 2017 issue of Applied Physics Letters.

UNDERGRAD WINS FULBRIGHT AWARD

Alexander Nicholas Alvara won a Fulbright U.S. Student Program award, which provides funding for research outside of the United States. Alvara, a triple major who just completed his degree in mechanical, aerospace and materials science engineering, will spend a year working on robotics at the University of Toronto and then plans to attend graduate school.

SAVING STORMWATER

A five-campus University of California collaboration, led by UCI civil engineer Stanley Grant, seeks to capture urban precipitation to augment water supplies. The $1.9 million grant from UC's Multicampus Research Programs & Initiatives will fund research and modeling to help usher in a new era of stormwater collection and management.

UC Stormwater Initiative

NEW APP ADVANCES MOBILE DATA TRANSPARENCY

Associate Professor Athina Markopoulou and her graduate student research team developed AntMonitor, a mobile app that can perform real-time detection and prevention of private information leaked from devices to the network. Currently in beta testing, AntMonitor is funded by a two-year $300,000 NSF EAGER grant and a $50,000 prize from the Data Transparency Lab.

BACK-TO-BACK REGIONAL WINS FOR CHEM-E-CAR TEAM

The Samueli School's Chem-E-Car team swept the American Institute of Chemical Engineers (AIChE) Western Regional competition earlier this year. The young engineers fielded two cars, with their Model S finishing in front of UCLA for best performance and their Steve-O team coming in first in the poster competition. For the third year in a row, Anteater engineers are attending this fall's national competition.

BEST PAPER AWARDS:

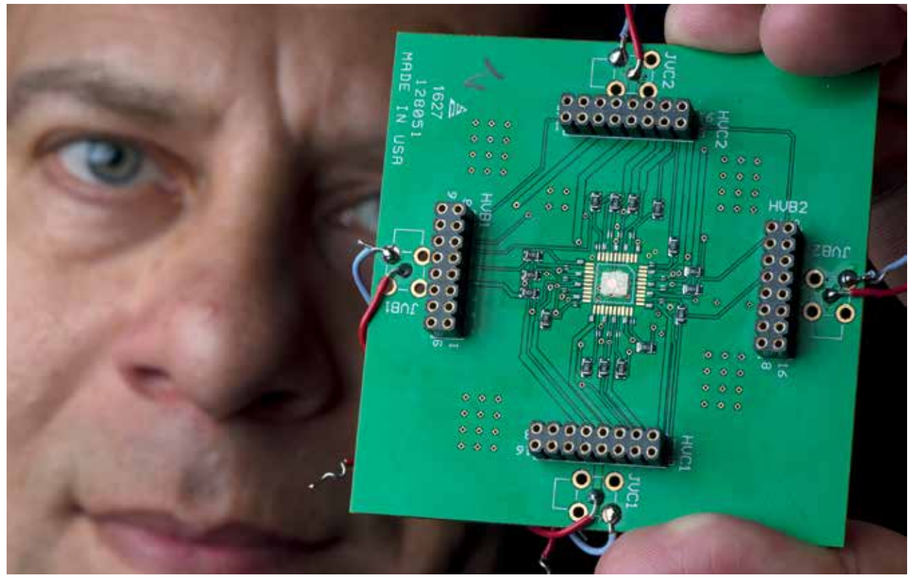
Graduate student Hua Sun won at the 2016 IEEE International Symposium on Information Theory. Sun, along with Professor Syed Jafar, also won the Communication Theory Symposium Best Paper Award at the IEEE GLOBECOM 2016 conference.

Doctoral students Alexandra Efimovskaya, Yu-Wei Lin and Danmeng Wang were recognized at the 2017 IEEE International Symposium on Inertial Sensors and Systems.

UCI Combustion Lab research team was selected at the ASME Turbo Expo 2017 conference.

Associate Professor Tim Rupert and his doctoral student Amir Khalajhedayati were awarded Best Paper honors from the Structural Materials Division of The Minerals, Metals & Materials Society.

“Our power and efficiency are an order of magnitude greater than other designs.”



RADIATOR BREAKTHROUGH

New component could revolutionize scanning, spectroscopy and wireless communication

Your doctor waves a hand-held scanner over your body and gets detailed, high-resolution images of your internal organs and tissues. Using the same device, the physician then sends gigabytes of data instantly to a remote server and just as rapidly receives information to make a diagnosis.

UC Irvine Professor Payam Heydari, electrical engineering and computer science, and his team of integrated circuit researchers have created a silicon microchip-based component that could make these and many other actions possible.

Known as a “radiator,” the tiny gadget emits millimeter-wave signals in the G band (110 to 300 gigahertz). Waves of this frequency easily penetrate solid surfaces and provide extremely sharp resolution, enabling new, more effective methods of biomedical and security scanning and imaging. The chips also can perform a key role in point-to-point wireless communication.

“We’re very excited about the successful design of this radiator because it represents a complete breakthrough,” said Heydari, a 2017 IEEE fellow. “We’re offering an entirely new kind of physics, a new kind of device really. Our power and efficiency are an order of magnitude greater than other designs.”

One of his lab’s graduate students, Peyman Nazari, designed the device as an octagonal semiconductor chip with a unique cavity structure that allows for the emission of circularly polarized radiation. Most transmitters now generate linearly polarized signals, which can get “lost” when antennas and receivers are out of alignment. Emissions from one of the UCI radiators, if you could see them, would appear as tiny spinning tornados. Beams of this shape are particularly effective at penetrating solid objects and providing detailed pictures of what’s inside.

The radiator tool combines power from multiple amplifiers; it modulates that signal to a desired frequency setting; and it radiates it out in waves that are used to see, sense or communicate.

“By making a single device that provides a multitude of operations, we’ve gotten rid of all the interstage, highly inefficient systems found in other radiators, and as a result, we can achieve higher power output,” Heydari said.

SEA LEVEL RISE

NOAA grants UCI $1.15 million for coastal research

Coastal communities have always been at the sometimes-mercurial mercy of the ocean. Now, with the help of national funding, UC Irvine researchers are hoping to better understand and mitigate sea level rise and storm surge impacts on changing coastal landscapes.

The National Oceanic and Atmospheric Administration’s (NOAA) National Centers for Coastal Science awarded the UCI team $1.15 million through its competitive Ecological Effects of Sea Level Rise (EESLR) program.

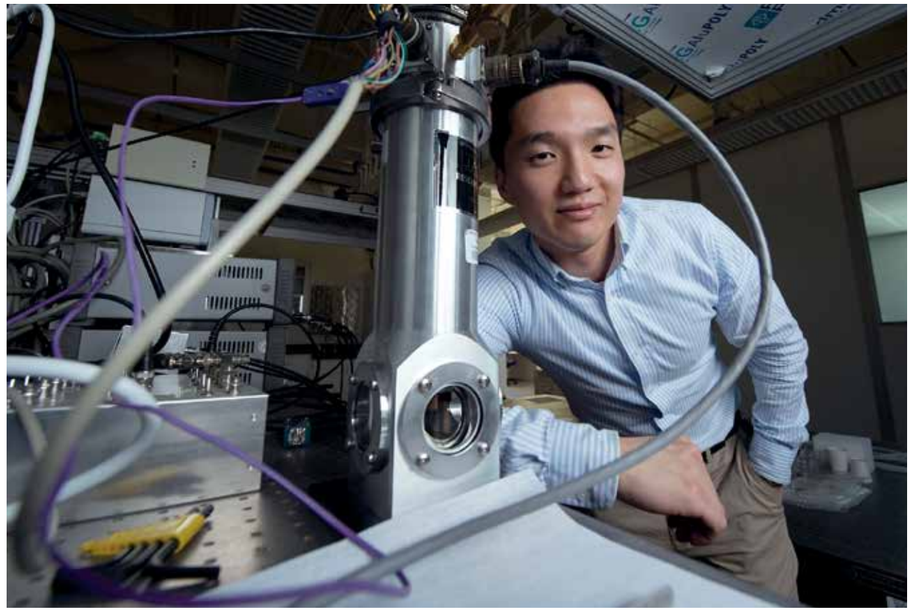
The four-year award is helping investigators explore new strategies for protecting and managing resources impacted by climate change. The researchers are partnering with the Southern California Coastal Water Research Project. Together, they will use a new modeling approach to analyze flood risk, sediment instability, erosion risk and habitat distributions under various climate change scenarios projected through the next 80 years. They will examine and compare alternatives in sediment management practices to see what might work best to protect and adapt coastal lowlands.

“Sediment is the most valuable resource we have for dealing with the risks of rising seas and storm events on coastal development, wetland habitat and the iconic beaches of Southern California,” said lead researcher Brett Sanders, professor and former chair of civil and environmental engineering. “This project will work toward sediment management policies and practices that respond to this challenge. We will also develop interactive modeling tools so communities can plan for the future.”

UCI civil engineer Amir AghaKouchak and social ecologist Richard Matthew are co-principal investigators on the grant.

UCI’s project is one of 10 that NOAA funded, totaling **$10.44 million** over the next five years to address sea level rise, hypoxia and harmful algal blooms.

More in-depth findings on this research can be found in last summer's issue of **Nano Letters,** where Lee is lead author.



THERMAL TRANSPORT

UCI engineer seeks to recycle waste heat

Jaeho Lee is familiar with heated exchanges. The assistant professor of mechanical and aerospace engineering is not argumentative, of course, but he has determined in groundbreaking work that very hot nanowires could help convert excess heat from machines and electronics into useable electricity.

As a postdoctoral researcher at the Lawrence Berkeley National Laboratory, Lee devised a method for analyzing nanowires at temperatures approaching 800 degrees Fahrenheit. He and his colleagues customized a commercially available vacuum chamber and related equipment with heat-tolerant wiring, using screws instead of glues to hold pieces in place. They also created a unique sample-mounting platform that minimized heat loss, allowing researchers to control the nanowires' temperature with high precision.

That work has informed his current research: an effort to measure the thermal conductivity of nanoscale materials at higher temperatures than previously possible.

"Auto manufacturers and tech startups are trying to utilize and commercialize heat-to-electricity applications, but first they need highly efficient building blocks to make that happen," said Lee. "Our work verifies what engineers have long expected: that certain materials would have good thermoelectric properties at the nanometer scale even at high temperatures."

One of the fundamental goals of Lee's area of research is decoupling electrical conductivity and temperature to produce energy from waste heat, and his work is demonstrating that silicon nanowires may be the right materials for the job.

In their quest to recycle waste heat, engineers are seeking elements that permit the smooth flow of electricity while resisting heat. In bulk, silicon is a good transmitter of both electricity and warmth. But scientists have long witnessed a sharp decrease in thermal conductivity when dealing with silicon at the micro- and nanometer scales.

"Heat scatters with the surface boundaries, so when you make a nanowire, the thermal conductivity could be as low as two orders of magnitude less than the thermal conductivity of the bulk material," Lee said.

RECOVERY ROBOTS

Stroke victims benefit from UCI-engineered device

Blame it on the movies, but people tend to think of robots as tireless factory workers or as soulless automatons bent on destruction. For UC Irvine graduate student Sumner Norman, they're all about healing and rehabilitation. The fifth-year doctoral candidate in mechanical and aerospace engineering studies robotics-based therapies to help stroke victims.

"I see an entirely different side to these technologies," he said. "The main goal of my research is to demonstrate that machines and humans can work well together."

Norman belongs to the biorobotics lab group headed by David Reinkensmeyer, UCI professor of biomedical engineering, mechanical and aerospace engineering, and anatomy and neurobiology. Members develop robotic and mechanical devices to help people recover from stroke- or accident-induced neurological damage.

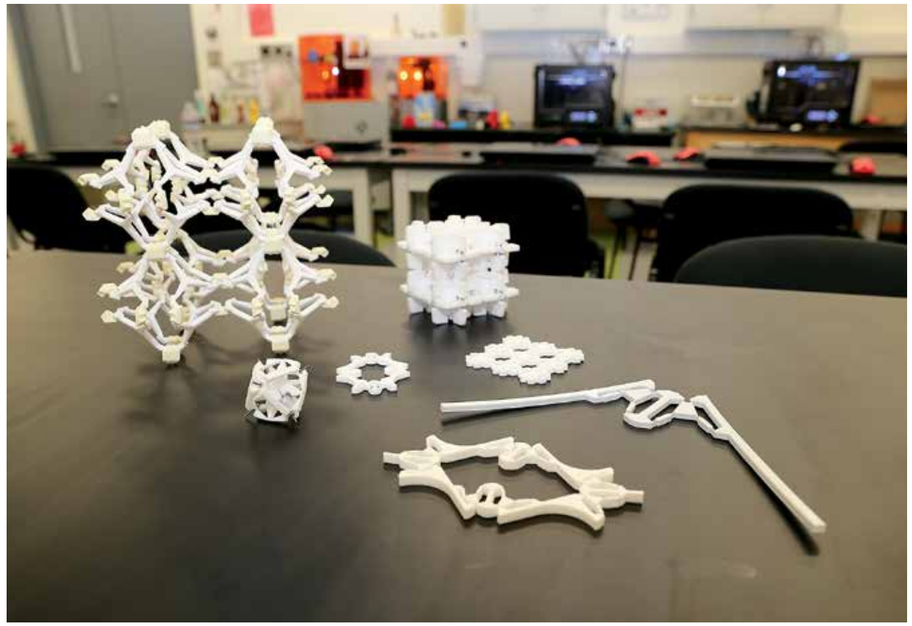
Stroke, the leading cause of disability in the United States, can damage parts of the brain that control speech and motor functions. For decades, patients have undergone physical rehabilitation to regain the ability to walk or use their arms. Norman's work seeks to add a technology component to movement therapy that's tailored to each individual's specific needs in order to achieve better outcomes.

"We work spatially, looking for different areas of the brain that show up during movements that are more successful," he said. "We connect patients with a robot and let them move with it. We can see when they do better and when they do worse. We look for regions of the brain that are headed in the right direction but may be difficult to access."

His core project is the creation of a computer interface that patients wear on their heads. The electroencephalogram device searches for brain states that correlate to movement success. According to the grad student, there are parts of the brain that are capable of recovery post-stroke. The objective is to use the device to train these regions to perform tasks previously handled by now-damaged areas.

"The idea isn't to replace human health care professionals, but to work with them," Norman says. "The robots are a tool for recovery."

795,000 people in the U.S. suffer strokes each year.



> This new design approach can open the door to so many new functionalities, all while working with existing materials.

THE SHAPE-SHIFTERS

Novel approach paves the way for manufacturing highly adaptable components

A screwdriver morphing into a wrench? Vehicles changing shape on demand? It sounds farfetched, but these applications are possibilities with a new approach to materials design under development in the laboratory of Lorenzo Valdevit, associate professor of mechanical and aerospace engineering.

The shape-reconfigurable material relies on a modular system of bi-stable units with hinges that allow individual building blocks to be combined and recombined in different ways to create multistable structures. The living hinges – thin, flexible connections of the same material as the two connecting pieces – allow the triangular units to snap into open or closed configurations.

By carefully tailoring the location of the hinges and the assembly of the modular blocks, one can design architected materials that morph between two or more desired shapes with great precision, while maintaining strength and providing energy absorption. This technique can be applied to a variety of constituent materials, including polymers, metals, ceramics and composites. Because the failure strain of the hinge material is critical to material selection, ongoing research is investigating how the hinge performance can be improved at the nanoscale. "Reducing the feature size in these materials is shown to be a possible solution for creating hinges that will undergo snapping without plastic deformation," says the research team in a paper published online in Advanced Materials.

One of the key benefits of this methodology, researchers say, is the reversibility between different stable states. This implies that the original or deformed configurations of the material can be infinitely recovered with no compromise in efficiency, integrity or structure life.

"What I find fascinating about this research is that you can achieve unique mechanical properties simply by controlling the shape of a periodic cellular solid; complexity comes from geometry, not from the properties of the base material. This new design approach can open the door to so many new functionalities, all while working with existing materials," said Valdevit.

DEADLY CONSEQUENCES

Climate change study serves as a wake-up call

An increase in mean temperature of 0.5 degrees Celsius over half a century may not seem all that serious. But a study led by UC Irvine researchers has determined it's enough to more than double the probability of a heat wave killing in excess of 100 people in India.

This could have grim implications for the future, because mean temperatures are projected to rise by 2.2 to 5.5 degrees Celsius by the end of this century in the low- and mid-latitude countries of the Asian subcontinent, the Middle East, Africa and South America.

"The impact of global climate change is not a specter on the horizon. It's real, and it's being felt now all over the planet," said Amir AghaKouchak, associate professor of civil and environmental engineering and co-author of the study, which was published in Science Advances. "It's particularly alarming that the adverse effects are pummeling the world's most vulnerable populations."

Using data gathered by the India Meteorological Department from 1960 to 2009, the UCI-led team analyzed changes in summer temperatures; the frequency, severity and duration of heat waves; and heat-related deaths.

They found that when mean summer temperatures in the South Asia nation went from 27 to 27.5 degrees Celsius, the probability of a heat wave killing more than 100 people grew from 13 percent to 32 percent – an increase of 146 percent.

India is currently home to over 1.3 billion people, nearly a quarter of whom live on less than $1.25 a day and have little to no access to electricity.

The study authors stressed that their findings should serve as a wake-up call for governments and international organizations to help improve the resilience of areas most vulnerable to climate-change-induced weather events.

> It's particularly alarming that the adverse effects are pummeling the world's most vulnerable populations.

The grant is part of the Public Safety Innovation Accelerator Program funded by NIST's **$300 million** allocation from the 2015 auction of advanced wireless service licenses.

SOS SOLUTION

Advanced technology implanted in shoes could help first responders save lives

Emergency responders often rely on GPS signals to locate those needing assistance. But what if those signals are unavailable? A UC Irvine engineering team is developing a chip-scale personal navigation system for use by emergency responders and others trapped in locations without useable GPS signals.

Aided by a $1.9 million grant from the National Institute of Standards and Technology (NIST), principal investigator Andrei Shkel, professor of mechanical and aerospace engineering, is designing the uNavChip, a microelectromechanical system that users can place in the sole of a shoe. The chip integrates deterministic, probabilistic and cooperative localization algorithms that Shkel hopes can achieve localization accuracy of 1 meter for hours of operation in GPS-denied environments.

"Localization, together with communication, are the key capabilities to achieve effective situation awareness, coordination and support in the case of emergency and recovery operations," said Shkel. "These functions are like oxygen – taken for granted when available and vital when suddenly lost."

The three-year grant is one of 33 NIST-funded research and development projects aimed at advancing broadband communications technologies for first responders. In total, the agency granted $38.5 million to projects intended to help modernize public safety communications and operations by supporting the migration of data, video and voice communications from mobile radio to a nationwide public safety broadband network, as well as accelerating critical technologies related to indoor location tracking and public safety analytics. NIST reviewed 162 proposals from a diverse pool of national and international applicants across industry, academia and public safety organizations.

Shkel's co-investigators are Solmaz Kia, UCI assistant professor of mechanical and aerospace engineering, and Zak Kassas, UC Riverside assistant professor of electrical engineering and computer engineering.

INNOVATOR OF THE YEAR

Michelle Khine Plays it Forward

5
Number of patents

4
Startup companies

RECOGNITION

National Institutes of Health Director's New Innovator Award

Fellow of the American Institute for Medical and Biological Engineering

Fellow of the National Academy of Inventors

AT UCI

Professor, Department of Biomedical Engineering

Director, Faculty Innovation, Samueli School

Director, BioENGINE

LIFE PHILOSOPHY

"Do or do not. There is no try."

The Samueli School's 2017 Innovator of the Year refuses to take life too seriously. In fact, Michelle Khine pays homage to play; she credits it for her long list of accomplishments and even suggests it is the key to creating future inventors.

When research funds were tight in her first faculty position at UC Merced, Khine created a microfluidics platform using her favorite childhood toy, Shrinky Dinks. Despite colleagues' admonitions that it could be career suicide, she published a paper on the process in The Royal Society of Chemistry's Lab on a Chip journal. The response from academia was overwhelmingly positive. "We had more downloads than all the other Royal Society of Chemistry journals," she says. "All I wanted to do was make a poor man's version of the silicon wafer."

The UC Irvine biomedical engineering professor has expanded that effort over the years. Her lab still shrinks materials to make a suite of technologies, including microfluidic tools for point-of-care-diagnostics and tissue engineering, flexible electronics and nanostructures for surface-enhanced sensing.

"We pattern everything very inexpensively at the large scale and shrink it down afterward," she says.

Khine, who was elected to the National Academy of Inventors this year, calls herself a "card-carrying entrepreneur." In addition to founding Shrink Nanotechnologies, Inc., she established three other companies and an outreach program to excite kids about science. Fluxion Biosciences, based on her dissertation, advances drug toxicity testing; Novoheart, which engineers bioartificial human heart prototypes to assist in drug discovery, is in the process of going public. Its stock soon will be listed on the Toronto Stock Exchange; and TinyKicks produces a wearable wireless smart sensor that captures fetal movement and uses data analytics to guide healthy pregnancy outcomes. Her outreach effort, A Hundred Tiny Hands, creates a series of hands-on educational science kits for children.

She also is creator and director of UCI's BioENGINE program for engineering undergraduates, which she implemented to create a new generation of entrepreneurs.

"The U.S. is experiencing a creativity crisis," says the professor, innovator, inventor, engineer and mother, who still advocates for play as an essential driver of imagination. "You only learn by playing," she is known for saying. "We play music, we play tennis, we play sports. Why can't we play science?"

FACULTY ACCOLADES

With their wealth of research experience and abundant accomplishments, Samueli School faculty represent the best and brightest in the field of engineering. From national awards to media recognition to international honors and research collaborations, our faculty continue to distinguish themselves.

The American Geophysical Union selected Associate Professor **AMIR AGHAKOUCHAK** for the 2017 Hydrologic Sciences Early Career Award. This honor recognizes outstanding contributions to the science of hydrology, education or societal impacts by a scientist at an early stage in his or her career, and acknowledges the researcher's promise of continued contributions to hydrologic science. AghaKouchak is one of 75 scientists to receive accolades from groups representing their disciplines within the American Geophysical Union, the world's largest Earth and space science society. He will receive the award at the AGU fall meeting in New Orleans in early December.

REGINA RAGAN, associate professor of chemical engineering and materials science, was named a Fulbright U.S. Scholar. Through the Fulbright Flex program, Ragan will collaborate with researchers at the Karlsruhe Institute of Technology in Germany. Ragan's research involves developing new processes in advanced manufacturing of nanoscale devices. She is developing technology that uses optical sensing to detect metabolites, which serve as biomarkers of disease. At KIT, she will implement her pioneering methods for nanomanufacturing nanophotonic devices and investigate their use in next-generation medical diagnostic tools.

The American Institute of Aeronautics and Astronautics selected Samueli School Professor **DIMITRI PAPAMOSCHOU** the recipient of its 2017 Aeroacoustics Award. Papamoschou, professor of mechanical and aerospace engineering, was recognized for outstanding contributions to the field of aircraft community noise reduction, specifically "seminal contributions to understanding noise generations in multistream supersonic jets, leading to one of the most promising noise-reduction methods in current development." An AIAA Fellow, Papamoschou researches new ways to suppress sound generated from aircraft engines by investigating compressible turbulence, jet and fan aeroacoustics, mixing enhancement and advanced microphone phased-array methods.

Forbes Magazine named **TIMOTHY DOWNING** to its 2017 class of 30 Under 30 in science. The annual recognition lists the 30 brightest young entrepreneurs, innovators and game changers under age 30 in 20 different industries. Downing, assistant professor of biomedical engineering, investigates how extracellular signals can influence the final fate of cells. His discoveries have larger implications in areas such as regenerative medicine and therapeutic interventions. "Receiving this recognition is a tremendous honor," says Downing. "It has also been very encouraging for me and my research team here at UCI. We hope to continue making positive contributions to science and the field of biomedical engineering."

The American Society of Civil Engineers' Environmental and Water Resources Institute has named Distinguished Professor of Civil and Environmental Engineering **SOROOSH SOROOSHIAN** the 2017 recipient of its Ven Te Chow Award. The honor recognizes lifetime achievement in the field of hydrologic engineering, and was given to Sorooshian "for his pioneering contributions to hydrologic science and water resources systems engineering, including hydrometeorology, hydroclimate studies and application of remote sensing with special focus on the hydrologic cycle and water resources issues."

SOLMAZ KIA won a five-year, $500,000 National Science Foundation CAREER award. Kia, mechanical and aerospace engineering assistant professor, researches networked control systems and cooperative robotics. Her research seeks to design, develop and analyze efficient, distributed, optimization algorithms, which can improve networked decision-making in many cyberphysical applications, including smart grids, sensor networks and smart transportation. The project will expand knowledge about these algorithms in three categories: design technique, efficient communication and transparent privacy preservation. Kia also will develop a multitiered education, mentoring and outreach plan to train the next generation of networked-systems professionals.

DARPA granted materials engineer **ALON GORODETSKY** a Young Faculty Award in support of his work to create smart fabrics for soldiers. The associate professor in chemical engineering and material sciences is one of 27 researchers nationwide to receive the prestigious award. Gorodetsky conducts research on understanding and emulating the adaptive properties of squid skin. He has developed high-throughput strategies to produce reflectin, a protein found in cephalopods, and has used the protein in reconfigurable color-changing technologies. Building on this work with the $500,000 award, Gorodetsky proposes to develop an unprecedented, first-of-its-kind class of electrically actuated, color-changing smart fabrics.

MOHAMMAD AL FARUQUE, electrical engineering and computer science associate professor, was honored by the Research & Development Council of New Jersey with a Thomas Alva Edison Patent Award. The award recognizes the most significant patents emerging from that state's research community. Before joining the Samueli School in 2012, Al Faruque was a scientist at the Siemens Corporate Research and Technology Center in Princeton, N.J., where the research originated; he continued his work on the algorithm at UCI. Al Faruque was recognized in the energy category for a patent that offers a collaborative, networked energy-management strategy for providing power to electric vehicle charging stations located in residential neighborhoods.

ACADEMIC DISTINCTIONS

13
National Academy of Engineering members

7
Presidential Young Investigator awardees

22
NSF CAREER awardees

5
NIH New Innovators

8
Endowed Chairs

7
Distinguished Professors

4
Chancellor's Professors

OVER PRESCRIBED

CD-BASED MICROFLUIDICS PIONEER FURTHERS TECHNOLOGY TO TACKLE GLOBAL HEALTH THREAT

LORI BRANDT DANIEL A. ANDERSON

> “I am endlessly curious. Right now, I’m thinking all about how to use this technology worldwide to solve health problems; it would be tremendous.”

WHEN MOST PEOPLE LOOK AT A COMPACT DISC PLAYER, THEY THINK MUSIC.

Not Marc Madou. He contemplates using centrifugal force to channel microliters of body fluids – urine or blood – from point to point to identify a disease or an infection. He sees a CD-based microfluidic medical diagnostic device.

A UC Irvine Chancellor’s Professor of mechanical and aerospace engineering, Madou pioneered the technology about 18 years ago. A powerful, affordable and potent medical diagnostic tool, it has since been commercialized by half a dozen companies.

Now, Madou is putting it to work on one of today’s biggest threats to global health: antibiotic resistance.

According to the World Health Organization, “antibiotic resistance is rising to dangerously high levels” in all parts of the world. New resistance mechanisms are emerging and spreading, threatening our ability to treat common infectious diseases. A growing list of infections – pneumonia, tuberculosis, blood poisoning and gonorrhea – are becoming harder, and sometimes impossible, to treat as antibiotics become less effective.

The threat is heightened in countries without standard treatment guidelines, where antibiotics are often over-prescribed and overused, and in places where they can be purchased without a prescription. WHO warns that without urgent action, we are heading for a post-antibiotic era, in which common infections and minor injuries can once again kill.

“Antibiotic resistance is a huge public health problem,” says UCLA pediatric urologist Dr. Bernard Churchill, who along with UCLA infectious disease specialist Dr. David Haake, has spent the past 15 years tackling the issue. They formed medical device company MicrobeDX and have turned to Madou to help take their idea to the next level.

Currently, the conventional process of detecting and identifying potential bacteria strains in patients with a possible urinary tract infection, for instance, takes 48 to 72 hours. That’s not counting transportation time for the sample to go from doctor’s office to laboratory. So in the majority of cases, physicians make an educated guess as to which antibiotic drug to prescribe – before the lab identifies the actual bacterium. According to Churchill, in the U.S. last year, 50 percent of these scrips were unnecessary, inappropriate or incorrect, contributing greatly to the development of antibiotic resistance.

Churchill and Haake created a diagnostic assay that more quickly detects and identifies the type of bacterium and then screens it for antibody sensitivity. “We wanted to completely revolutionize the field of diagnostic microbiology,” says Churchill. “It was too slow, big and cumbersome.”

This new assay uses ribosomal ribonucleic acid (rRNA) and a biosensor, giving the medical community the information it needs for evidence-based antibiotic therapy in less than three hours. However, it is still performed in a laboratory. The next challenge is to affordably scale up the process and reduce the time it takes to transport samples. That’s where Madou and his 10-member team of graduate students come in. Turns out his spin stand and microfluidic CD design capabilities are a perfect match for this bacteria identification and antibody sensitivity test.

“This is a fantastic assay,” says Madou. “We’ve put all the steps on our platform, and we not only automate it but can make it better, faster and more reproducible. And the entire test can take place in the doctor’s office or health clinic, wherever the specimen has been collected.”

Alexandra “Sasha” Perebikovsky, a Ph.D. student in physics and lead researcher in Madou’s bioMEMS lab, explains that the original benchtop assay, conducted manually, involved 88 steps and huge preparation. “We were able to drastically simplify the process by condensing it to five basic steps. We also cut the time needed for the bacteria to grow by improving the incubation with oscillation and a heated chamber.”

The spin stand, or box, is custom designed for the assay. It includes a motor, an array of magnets, small heater, laser valving and a camera for detection.

Marc Madou, a fellow of the National Academy of Inventors, is a leading expert in scalable nanomanufacturing technologies. He hopes to apply his CD-based microfluidic technology to health problems in remote areas of developing nations around the world.

76%

of people mistakenly think antibiotic resistance occurs when the body becomes resistant.

Once they hooked up with Madou, MicrobeDX made rapid progress. "It was really the ideal platform for operationalizing our assay," says Mazi Zarrehparvar, MicrobeDX president. "So many functions are doable in a CD format, and Marc came up with a cell lysis approach on a CD that outperformed anything that we'd ever seen, even with expensive machines and traditional approaches."

"CURRENTLY, THERE IS NO PROVISION OF DIAGNOSTIC FACILITIES IN RURAL AREAS IN INDIA. WHATEVER LITTLE IS AVAILABLE IS OF VERY POOR QUALITY AND UNRELIABLE."

Madou envisions applying this technology to health challenges in the U.S. and around the world. He says that when scaled up, CD-based microfluidic technology could help solve many health problems in rural remote areas of developing nations and resource-constrained environments: places like India, Africa and Mexico, where people have scarce access to health care.

He calls it extreme point of care, or EPOC, and he is working with Dr. Satadal Saha and engineer Chandra Sharma on a plan to implement this idea in rural India, under an Indian government-funded multi-institutional research project called Impacting Research Innovation and Technology (IMPRINT).

"Currently, there is no provision of diagnostic facilities in rural areas in India. Whatever little is available is of very poor quality and unreliable," says Saha, a co-principal investigator on IMPRINT. Diagnostic and other technologies are either too expensive, making it unaffordable for the poor, or require sensitive environmental conditions and skilled labor for operation – criteria often not available in rural environments. "Samples, when transported far for tests, deteriorate due to improper handling and storage. If patients travel far for tests, the consequent secondary expense (travel, food, lost daily wages) is enormous, thus acting as a detriment."

As a pilot endeavor, Saha and his team have established three rural health kiosks in remote villages in West Bengal, staffed by local women formally trained as health workers, who deliver very basic medical care. The workers use an innovative software system to share data with remote doctors who then decide on a clinical management plan. The health worker can communicate with the doctor over the phone to prescribe medication and give patient instructions.

"With Marc's ideas and MicrobeDX technology, we could enable the health workers to undertake diagnostic tests at the kiosks," says Saha. "The results will automatically feed into the software ecosystem and generate a comprehensive dataset for the patient's management plan."

This technology could go a long way toward improving health care by identifying bacteria and testing for antibody sensitivity. It can also rule out diseases, preventing misdiagnoses and unnecessary prescriptions. In total, Madou has designed multiple assays for use with CD-based microfluidic diagnostics, and he's working on a next-generation version with a smartphone attachment.

In a recent TEDx talk, Madou explains what drives him: "For me, being a scientist and being curious are all the same thing. It's life. I am endlessly curious. Right now, I'm thinking all about how to use this technology worldwide to solve health problems; it would be tremendous."

CAUSES OF ANTIBIOTIC RESISTANCE

Antibiotic resistance happens when bacteria change and become resistant to the antibiotics used to treat the infection they cause.

CONTRIBUTING FACTORS

- Over-prescribing of antibiotics
- Patients not finishing their treatment
- Overuse of antibiotics in livestock and fish farming
- Poor infection control in hospitals and clinics
- Lack of hygiene and poor sanitation
- Lack of new antibiotics being developed

Source: World Health Organization

PORING OVER RAIN

WILLIAM DIEPENBROCK STEVE ZYLIUS

RENOWNED WATER ENGINEER BRINGS UNBRIDLED INTENSITY TO PRECIPITATION RESEARCH

> The challenge is to understand how predictions can be done earlier and better.

1938

Southern California's deadliest flood of the 20th century kills more than 100 people.

LESS THAN A YEAR AFTER ARRIVING AT UC IRVINE, THE UNIVERSITY'S NEWEST WATER SCIENCE ENGINEER IS ALREADY DEEPLY IMMERSED IN SOME CRITICAL – AND UNFORTUNATELY, TIMELY – RESEARCH. Her groundbreaking work has long-term implications for how California and other Southwestern states may manage water and allocate resources to fight surging wildfires exacerbated by a warming climate.

Meet Efi Foufoula-Georgiou, who didn't just hit the ground running upon her arrival at UCI – she arrived on a bullet train that quickly scooped up a team of fellow researchers without losing an iota of momentum.

"I am always intrigued by new and challenging problems," Foufoula-Georgiou says. "If something captures my attention, I delve into it, rather than just talk about it. And it is always much more fun when collaborators are as excited as I am about it, too."

Foufoula-Georgiou, a UCI Distinguished Professor who hails from Greece, earned a degree in civil engineering in 1979 en route to receiving a Ph.D. in 1985 in environmental engineering – a field she says allows her to mesh her abilities in math and science with her love of the environment.

Since then, her career has been replete with environmental roles and research projects – from a presidential appointment to the Nuclear Waste Technical Review Board and service as director of the National Center for Earth-surface Dynamics at the University of Minnesota to being named chair of the Board of Directors for the Consortium of Universities for the Advancement of Hydrologic Sciences. She also served as a member of the National Science Foundation Advisory Council for Geosciences and was president of her scientific community, the hydrology section of the American Geophysical Union, from 2014-16.

To Foufoula-Georgiou, each new research project and collaboration helps to further understanding of the complex relationship between water, the earth and life, especially the factors that drive critical changes in precipitation and landforms.

"Understanding this complexity is at the core of everything I've done," she says. "Complex systems defeat the reductionist approach of study. They require new methods of analysis and new perspectives to reveal patterns and then relate them back to the underlying physics."

One of Foufoula-Georgiou's favored paths for discovering new perspectives is captured in her penchant to assemble and lead multidisciplinary teams whose expertise can range from civil engineering to anthropology. Colleagues say such teams play to Foufoula-Georgiou's strength at seeing the connections between disparate fields of study.

"Efi finds out who the people are who have the expertise to solve a problem and brings them together in one room," said Paola Passalacqua, an assistant professor of civil engineering at the University of Texas, Austin. "She's always in a constant search for what can be done, what is exciting, what is needed, what can change the community."

Passalacqua was a Ph.D. student and postdoctoral team member under Foufoula-Georgiou at the University of Minnesota.

Foufoula-Georgiou shepherds her research teams with a personable nature and unmatchable drive, adds Jon Schwenk, a fellow at the Los Alamos National Labs who worked with Foufoula-Georgiou as a Ph.D. student at Minnesota and as a postdoctoral assistant at UCI.

"If I had to describe her in one word, it would be intense," Schwenk says. "When she gets excited, there's no holding her back. Just hold on for the ride."

Already, Foufoula-Georgiou is assembling a UCI team to tackle an issue critical to California and neighboring Southwestern states: how to improve predictions for seasonal precipitation so the region can better manage limited water resources.

Typically, predictions for the region are driven by two measures: persistent high-pressure ridges over the Gulf of Alaska and the highly publicized cycle of changes in ocean surface temperature known as El Niño and La Niña.

The project targets El Niño/La Niña, which despite media attention, are not always so accurate.

El Niño is supposed to bring warm waters and increased winter rainfalls. La Niña is expected to bring colder water and less rain. But, during plenty of cycles, rain arrives without a strong El Niño and doesn't dry up despite a La Niña. And, the earlier in the season one looks for correlations between the cycle and winter rain, the less accurate a predictor it becomes.

In fact, the El Niño/La Niña model returns an accuracy rate of only 30 to 50 percent.

So Foufoula-Georgiou and colleagues set out to find stronger indicators of winter precipitation, analyzing reams of temperature and precipitation data gathered over the last 60-plus years.

Jackpot.

They discovered a region in the subtropical Southwestern Pacific where surface temperature patterns correlate more strongly than El Niño and La Niña with winter precipitation in the southwestern U.S., promising more accurate predictions three months ahead of winter. With UCI atmospheric scientists, they offered a physical explanation for such emergent patterns and postulated why this relationship has amplified over the past three decades, overshadowing El Niño/ La Niña indicators.

"The challenge is to understand how predictions can be done earlier and better," Foufoula-Georgiou says. "If you know early on that you will have a drought year, you can plan for the deficit. If you know you will have a wet year, you can plan for hazards, such as landslides."

The American Meteorological Society recognized Foufoula-Georgiou last fall with the Hydrological Sciences Medal for "her pioneering contributions to the science of hydrometeorology and for visionary and sustained leadership in advancing interdisciplinary hydrologic research."

20

Samueli School faculty are conducting water-related research.

Many questions remain for exploration.

For example, it isn't certain how large-scale circulation patterns will continue to change in a warmer climate, how these in turn will modulate changes in regional precipitation patterns and extremes, and whether these changes are captured in Global Circulation Models used for future predictions.

"THE POLICY PEOPLE NEED TO CLOSELY COLLABORATE WITH THE SCIENTISTS, AND THE SCIENTISTS NEED TO HAVE THE EAR OF THE POLICYMAKERS. NOT ALL OF THE SCIENCE WE DO FINDS ITS WAY INTO POLICIES UNLESS WE ASK AND ANSWER THE RIGHT QUESTIONS."

To get to those and other answers, Foufoula-Georgiou is proposing an interdisciplinary team that includes 14 researchers from across the university. Called the UCI Climate-Water-Ecosystems (CWE) Team, the group includes experts in Earth science and ecosystems, civil engineering and hydrometeorology, computer science and statistics, policy and management, social anthropology and environmental planning.

She explains why the CWE team's expertise needs to range so widely.

"The policy people need to closely collaborate with the scientists, and the scientists need to have the ear of the policymakers. Not all of the science we do finds its way into policies unless we ask and answer the right questions," Foufoula-Georgiou says, adding that she's learned the importance of being able to communicate scientific discoveries to those who make policy during her 30-plus years of leading research projects.

In addition to research on climate-precipitation predictability, Foufoula-Georgiou also is tackling the challenge of improving the quality of precipitation observations from space. With two peers from UCI and Colorado State University, she is addressing ways to quantify the accuracy and resolution of multisatellite products of precipitation and develop new algorithms that better capture extremes.

"We really have to keep working on improving global precipitation observations and assimilating them into models for better predictions at local to regional scales," she says.

The renowned hydrology engineer is also working with NASA on ways to improve satellite estimates. NASA has used satellites to gather near-surface precipitation data for decades, providing more detailed information than land-based information – especially over large swaths of ocean and hard-to-reach mountainous areas.

One such satellite was launched in 1997 for the Tropical Rainfall Measuring Mission. The TRMM satellite, designed to operate for three years, instead provided 17 years of data.

NASA built on the effort by connecting a system of satellites for its Global Precipitation Measurement mission in 2014. The GPM system provides more detailed information and greater coverage than TRMM, but it also faces significant challenges with estimation of land precipitation.

"It is indeed challenging to accurately estimate precipitation over land using space-borne microwave sensors. Radiation from the ground interferes with the emission and scattering of radiation from droplets within the clouds, resulting in a large signal-to-noise ratio. This is especially so over snow-covered areas and coastal zones," says Foufoula-Georgiou, who as part of the GPM project uses advanced mathematical analysis and synthesis techniques, collectively known as inverse estimation methods.

Meanwhile, she's also busy launching new efforts at UCI in collaboration with scientists at UC Berkeley. In June, she began the first steps of a project to explore the role of hydrology in California's persistent issue with landslides.

"It's really an amazing bit of synergy," she says.

Credit: Britt Griswold

About the GPM Mission

The Global Precipitation Measurement (GPM) mission is an international partnership co-led by NASA and the Japan Aerospace Exploration Agency (JAXA) that provides the next-generation global observations of rain and snow. Building upon the success of the Tropical Rainfall Measuring Mission (TRMM), the GPM concept centers on the deployment of a "Core" satellite carrying an advanced radar/radiometer system to measure precipitation from space and serve as a reference standard to unify precipitation measurements from a constellation of research and operational satellites. Through improved measurements of precipitation globally, the GPM mission is helping to advance our understanding of Earth's water and energy cycle, improve forecasting of extreme events that cause natural hazards and disasters, and extend current capabilities in using accurate and timely information of precipitation to directly benefit society.

Source: https://pmm.nasa.gov/GPM

IMITATION GAME

RESEARCHERS REDESIGN MOLECULES FOUND IN NATURE TO CREATE NEW MEDICAL THERAPIES

ANNA LYNN SPITZER DEBBIE MORALES

Wang and her team use a strategy known as biomemetics – imitating methods and systems found in nature in order to solve complex human problems. The chemical engineering and materials science professor collaborates with several other departments and schools, including biomedical engineering, medicine and immunology.

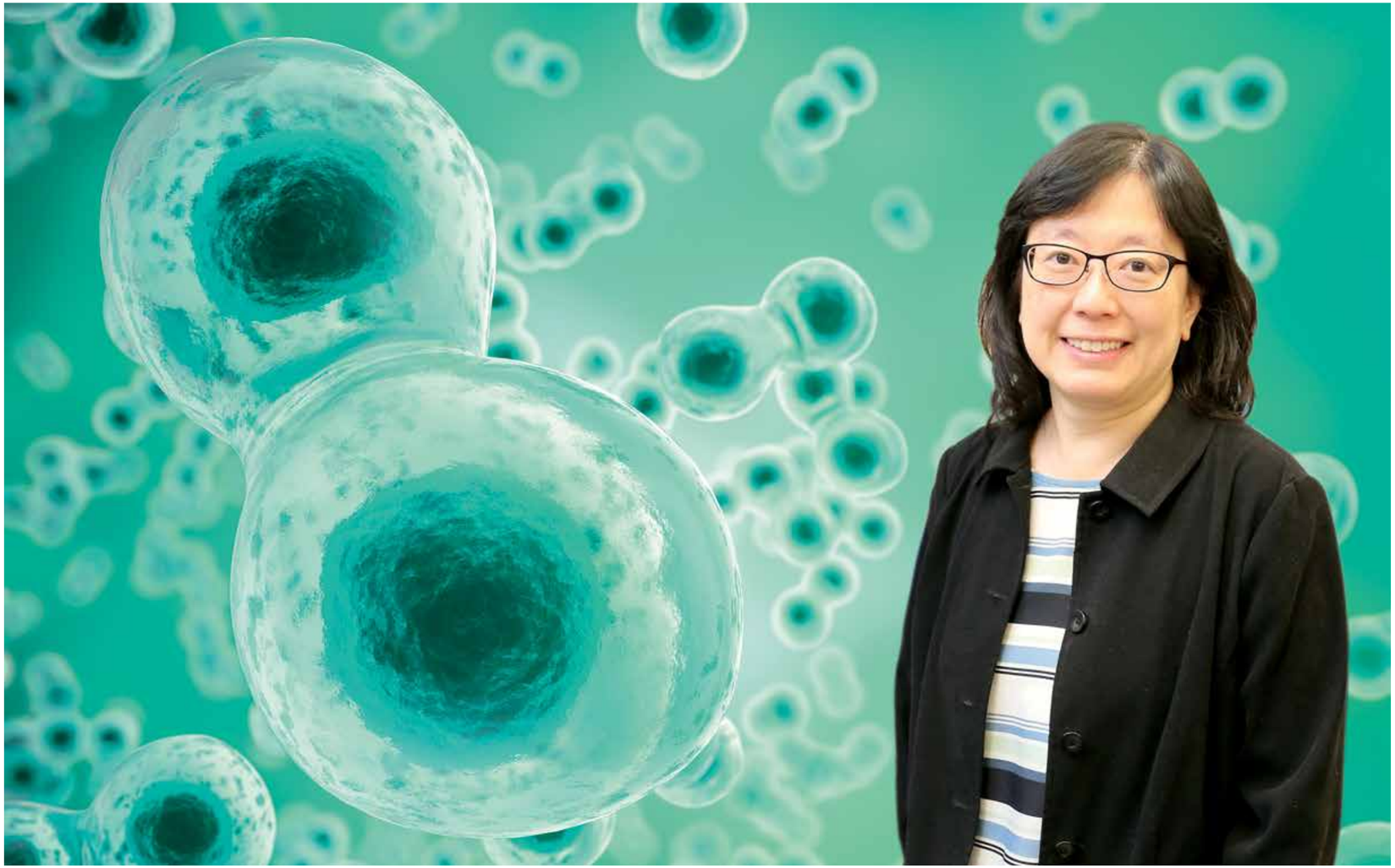
MOTHER NATURE IS AN OLD PRO WHEN IT COMES TO ASSEMBLING MINISCULE NANOMETER-SIZED BUILDING BLOCKS INTO LIVING, BREATHING ORGANISMS. Now, UC Irvine researchers are following her lead as they develop innovative applications that could benefit human health. By redesigning naturally occurring protein nanoparticles – altering them with chemistry or genetic manipulation – they hope to deliver drugs, create cancer-fighting vaccines and engineer materials for biomedical implants.

"WHEN WE FIRST STARTED, THERE WERE MANY DIFFERENT AVENUES THAT WE EXPLORED, BUT THE BIOMEDICAL RESEARCH HAS REALLY TAKEN OFF. THAT'S BEEN SO EXCITING TO ME BECAUSE YOU CAN SEE MEDICAL APPLICATIONS THAT CAN EVENTUALLY HELP PEOPLE."

The team, led by the Samueli School's Szu-Wen Wang, professor of chemical engineering and materials science, is using a strategy known as biomimetics, or biomimicry. "It all goes back to how the structures are made," says Wang, who won last year's Samueli School Mid-Career Faculty Excellence in Research award. "We look at how nature does this, how it creates them and what it uses them for. Then we try to take these fundamental structures and redesign them for a new purpose."

The team currently focuses on two efforts: creating hollow structures that can carry drug molecules inside them; and manipulating polymer chains to interact with cells in specific ways, in an attempt to decrease the inflammatory response caused by foreign bodies.

One of nature's many brilliant designs is a hollow "buckyball"-type nanoparticle with multiple layers on its surface, each responsible for a different



> "When we package cancer proteins like they're viruses, we obtain a much higher immune response against tumors."

1985

Buckyballs, also known as "fullerenes," were created in a laboratory. The carbon molecules held exactly 60 carbon atoms, arranged into a spherical shape, which resembled the futuristic "geodesic" domes invented by Buckminster Fuller in the 1930s.

function. Wang's team has genetically removed these outer layers and changed the surface properties so that a variety of molecules – either synthetic or biological – can attach and provide the structure with new properties. They also can chemically change the particle's internal properties, allowing them to encapsulate drugs or other molecules.

What's more, the team has learned how to open and close these nanoparticles by controlling how they assemble and disassemble. This could allow the particles to easily release the drugs they're carrying when they arrive at a pre-determined destination.

With a joint appointment in the Department of Biomedical Engineering, Wang and her research team, along with Dr. Edward Nelson's research group in the School of Medicine, also are investigating whether biomimetics could help design more effective cancer vaccines. Studies over the last several years have shown elevated immune responses to experimental cancer vaccines, but they were nowhere near the level needed to eradicate the cancer.

Wang realized that proteins used in currently successful vaccines – for example those for flu – are similar in size and structure to the particles her team is working on. "We've repackaged our nanoparticles so they look like a virus to the body, but we substitute in cancer proteins instead," Wang explains, adding that the design also includes foreign DNA that causes the body's immune system to activate. They hope this will teach the body to respond to cancerous cells the way it does to cells infected with the flu virus.

Initial testing in mice has been positive. "When we package cancer proteins like they're viruses, we obtain a much higher immune response against tumors," she says, adding that they have experimented with several different types of cancer and the response has been similarly effective.

While this project seeks to increase the body's immune response, another uses biomimetics to decrease it.

In a UCI multidisciplinary collaboration, Wang's team has partnered with biomedical engineer Wendy Liu, Nancy Da Silva from chemical engineering and materials science, and immunologist Andrea Tenner to create collagen-mimetic biopolymers that can inhibit the body's inflammatory response toward therapeutic materials.

The body naturally produces collagen – long, thin strands of polymers – that interacts with cells via specific sites (protein sequences). Receptors on the cells' surfaces bind tightly to particular locations within the collagen, sending a signal that tells the cell what to do. Wang and Da Silva have shown that cellular responses can be regulated through interaction with synthetic collagen-mimetic polymers in the same way the process occurs naturally. They have developed a strategy that enables molecular-level manipulation of these collagen biopolymers.

"Szu and I have collaborated on the collagen project for more than 10 years, bringing together our joint experience in molecular level design, her expertise in biomaterials and my expertise in yeast engineering," says Da Silva. "A key aspect of the work is the novel modular strategy for synthesizing the collagen genes … In addition to the manipulation of cell binding and biopolymer properties, the system holds great promise for modulating immune system response and for tissue engineering and stem cell applications."

The body's immune response is the province of macrophages, a type of white blood cell that serves as the body's sentry. These immune cells protect against infection by engulfing and digesting cellular debris, foreign substances, microbes and other materials that lack specific proteins on their surfaces. Unfortunately, this process usually causes rejection of implanted therapeutic devices.

Researchers previously had learned that specific protein sequences in the collagen strand can inhibit immune cell responses by interacting with a

Graduate students Medea Babaie Neek (left) and Tae Il Kim work in the lab. "I feel like the grad students are the ones who do the hard work," says Wang.

particular protein receptor. In this case, the binding interaction instructs the immune cells to decrease their activation response. The collaborators are seeking to produce these reactive snippets of collagen-like polymers as a coating for biomedical materials and devices. Initial results show promise.

"The foreign-body response to biomaterials remains a challenge in modern medical treatments that involve implantation of a device or material into the body," says Liu. "Macrophages are key regulators of inflammation during wound healing, and we are very excited about the results of this collaboration. We believe these interactions may be useful for designing new biomaterials with an improved wound-healing response."

If they are successful, the body could more readily accept implants like biosensors, catheters and stents, because the coating would suppress the body's natural inflammatory response to them. These coatings also could have applications on the team's drug-delivery nanoparticles.

Wang is encouraged by the results of her group's work. "When we first started, there were many different avenues that we explored," she says, "but the biomedical research has really taken off. That's been so exciting to me because you can see medical applications that can eventually help people."

ONE MOLECULE AT A TIME

A PROLIFIC INVENTOR BRINGS TO LIGHT
A NOVEL VIEW OF NANOTECHNOLOGY

ANNA LYNN SPITZER PAUL KENNEDY

THE WORLD IS WITNESSING A NEW INDUSTRIAL REVOLUTION. UNFORTUNATELY, WE ARE HAVING A HARD TIME REALLY SEEING IT.

An explosion in advanced nanotechnology tools and techniques is fueling innovation in materials, goods and medical therapies but the nano-sized mechanisms that comprise these products are invisible to the human eye. Even today's high-powered scanning electron microscopes are limited in their ability to visualize the minuscule structures that most often self-assemble via chemical reaction. And, because most SEMs operate in a vacuum, they are further limited in the materials they can examine and the information they can provide.

It is fortuitous, then, that Kumar Wickramasinghe, intrepid inventor and Henry Samueli Endowed Chair, had the foresight to co-invent a microscope that can visualize nanomaterials and biological systems with nanometer resolution. The Photo-induced Force Microscope, which Wickramasinghe created with former colleague Sung Park, allows scientists to study the surfaces of these minuscule materials at the molecular scale by detecting the force caused by the presence of light.

Not only can the instrument map a structure's surface, it can pinpoint and identify molecules by their distinctive molecular signatures. Furthermore, researchers believe it can help make movies of single molecules in action by employing very short pulses of light. And, it can operate outside of a vacuum, making it useful for examining biological samples.

Using light – the microscope has top, bottom and side illumination – the photo-induced force microscopy (PiFM) technology detects the force between the tip of the microscope and the sample. Because the microscope can measure the vibration signals emitted by single molecules, users can identify each molecule on a material's surface and build a visual representation of material and biological systems at nanometer-scale resolution.

This capability is important for a number of reasons. One, Wickramasinghe explains, is molecular rotation. Molecules can rotate light in left-handed and right-handed directions, changing very similar molecular formulas into drastically different mixtures. This is especially crucial in drug compounds, where a slight modification in the rendition of molecules can transform a life-saving medication into a poison. "Right-handed molecules essentially have the same chemical formulas as left-handed molecules but slightly different structures; this microscope lets us see those things," he says.

Additionally, in polymer science, most molecules self-assemble, so it's important to make sure they do so according to plan. Until now, there has not been a way to verify this. "These microscopes allow us to see exactly whether a molecule is going to the place you want it to go," adds Wickramasinghe.

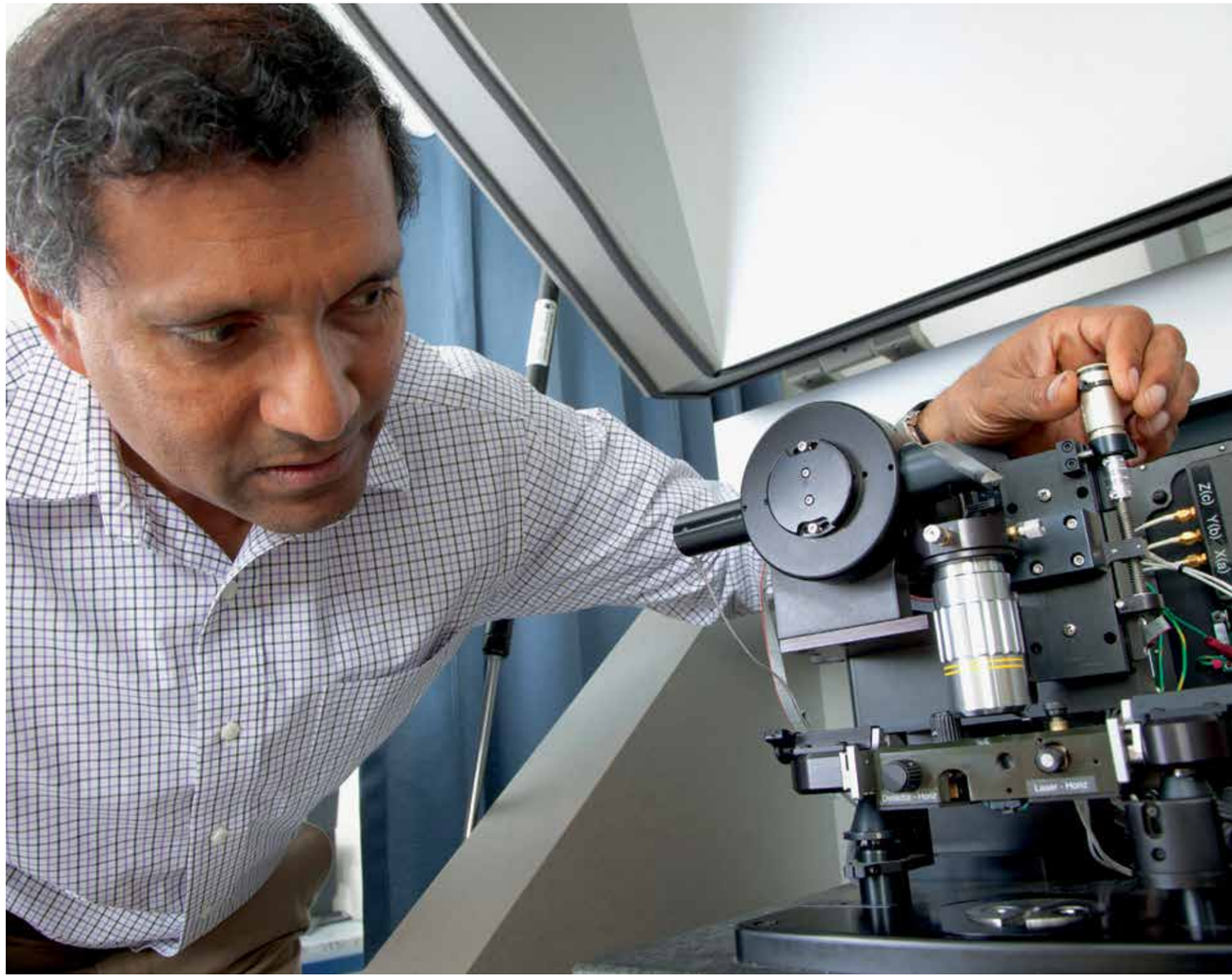
He and Park spun off the technology into a company called Molecular Vista, headquartered in San Jose, Calif. The company has sold its microscopes to universities in the U.S. and abroad. UC Irvine has three.

One of those is in the Department of Chemistry, where Wickramasinghe is collaborating with physical sciences faculty to study previously inaccessible properties of matter. Matter has both electronic and magnetic properties but light's electric field is much stronger than its magnetic field in propagating light waves. Therefore, most light-based microscopes can access electronic energy states more easily.

But there is much to be learned from matter's response to magnetic fields. For the first time, this PiFM technology affords scientists the opportunity to observe magnetic interactions, which could have applications in CD storage, molecule orientation,

> "These microscopes allow us to see exactly whether a molecule is going to the place you want it to go."

Wickramasinghe, an intrepid inventor, has been responsible for developing a series of high-tech instruments that measure heat, light, magnetism and force on a nanometer scale.



ONE

nanosecond is one-billionth of a second.

drug development and more. "It's really hard to predict what new applications may come out of this," says Wickramasinghe. "It's a whole new set of dark states of matter that have not been accessed before."

Chemistry professor Eric Potma, who is collaborating with Wickramasinghe, says, "On the nanoscale, optical magnetic interactions can grow as strong as their electric counterparts, but it has not been easy to visualize the magnetic field of light at such scales."

He adds: "If this is successful, optical magnetic fields can be mapped out with great precision on the nanoscale, which would be a unique capability of direct relevance to developing new optically active nanomaterials."

In another collaboration with UCI's Chemistry at the Space-Time Limit center, researchers are using PiFM to try to make real-time videos of individual molecules in action. By shooting very short pulses of light at molecules, scientists can freeze the action at extremely short time spans – about 10^{-6} nanoseconds – capturing reactions as they occur. "These short pulses of light can give you a snapshot," according to Wickramasinghe. This can lead to better understanding of electron transfer, structural dynamics and chemical reactions.

This innovative approach opens the door to the previously impossible. "With Professor Wickramasinghe's technique, we have been able to do such ultrafast optical experiments on the nanoscale, a scale previously unthinkable for these kind of measurements," Potma says. "Ultimately, this approach promises a new view of molecular dynamics, one molecule at a time."

In seemingly unrelated – but someday, possibly very related – research, Wickramasinghe is overseeing two other projects that could greatly improve disease diagnosis and drug development.

The electrical engineer is building consumer-friendly silicon chips that can detect the onset of disease or monitor genetic changes that can trigger progression of disease – such as cancer– within minutes, by detecting specific DNA sequences in bodily fluids. Users would put a drop of blood or other fluid into the chip, seal the compartment and turn on the processor. The chip, treated with specific DNA sequences, will find and attach to matching DNA in the blood sample, amplifying the DNA roughly a billion times so it can be detected electrically and identified.

Each chip could hold up to 100 different DNA sequences in individual compartments, allowing a single chip to rapidly identify that many different conditions or diseases. Wickramasinghe envisions the device encased in a small, Fitbit-like package that will plug into a user's cell phone and deliver results in minutes.

The engineering visionary, who is credited with developing a long list of high-tech tools and instruments including the vibrating mode AFM, silicon tips and the AFM jet for rapid molecule sorting and delivery, recently won a Proof of Product grant from UCI's Applied Innovation for the rapid DNA test idea. He hopes to add this device to his growing list of commercialized products. "This is pretty exciting. I think it could have lots of applications," he says.

The last in his trilogy of "things that excite me now" is a project that examines and even modifies the genetic code of cells. Using an electrically driven nano-pipette, he has successfully injected DNA sequences into a cell's nucleus. The nucleus has incorporated this new DNA into its own genome while continuing to grow and divide. This advancement could allow for better understanding of the cell's network of genetic pathways and lead to more individualized disease treatment.

His team also has used the nano-pipette to extract cell material, allowing scientists to examine what proteins the cell is producing. "What the cell does is very much driven by the different proteins it is making," Wickramasinghe says.

> "WITH PROFESSOR WICKRAMASINGHE'S TECHNIQUE, WE HAVE BEEN ABLE TO DO SUCH ULTRAFAST OPTICAL EXPERIMENTS ON THE NANOSCALE, A SCALE PREVIOUSLY UNTHINKABLE FOR THESE KIND OF MEASUREMENTS."

Coupled with his previous research, which resulted in a method for removing Messenger RNA from a cell using the tip on an atomic force microscope, this technology gives scientists a new way to study drug interactions on a cellular level.

Wickramasinghe's goal is to combine these currently separate technologies into a single tool that can examine and change the genetic structure of a single living cell. "We envision treating a population of living cells with a drug, going into a cell and quantifying the cell's behavior before and after drug delivery. Then we can understand if the drug is doing what the manufacturers have designed it to do," he says.

"If you can do it on one cell, while it's still alive, then you are basically studying the whole system," Wickramasinghe explains. "If you study many cells, you get an average and that is not as good.

"To study what's going on, you really need to study single cells," he summarizes, lending credence once again to his theory that – assisted by his groundbreaking technology – one can gain the largest quantity of information by examining the smallest available element.

BUSINESS CLASS

NEW SENIOR PROJECT DESIGN PROGRAM INSTILLS ENTREPRENEURIAL SKILLS

ANNA LYNN SPITZER STEVE ZYLIUS SHARON HENRY

196

Students have learned the finer points of entrepreneurship through the BioENGINE program.

THE STUDENTS IN BIOMEDICAL ENGINEERING 180A ATTEND CLASS OFF-CAMPUS, IN A BRIGHTLY LIT, CHEERFUL SPACE WITH A SILICON VALLEY VIBE.

Surfboards hang from the industrial-type ceiling and students kick back in beachy Adirondack chairs and lime green seats. Surrounded by giant wall-mounted screens that flash upcoming events, the undergraduates come to listen to industry experts explain business plans and venture capital.

Welcome to UC Irvine's BioENGINE – Bioengineering, Innovation and Entrepreneurship – a class that teaches business and management skills to fledgling engineers in an effort to encourage a new generation of entrepreneurs.

The setting is no accident. "We want them to have an immersive experience as they learn," says William Tang, biomedical engineering professor and the program's lead instructor. "Being in a place that feels like a startup has a real psychological impact on the students."

While experiential learning has long been a staple of UCI's undergraduate engineering education, these students are learning to commercialize what they create.

BioENGINE is a required course for biomedical engineering undergraduates, along with chemical and biochemical engineering students. The yearlong class brings together faculty and businesspeople to lecture and serve as mentors to the five- and six-member student teams as they design, manufacture and prepare their medical devices and apps for commercialization. Coursework includes business planning, market research and distribution, teamwork, leadership and the art of the pitch.

Biomedical Engineering Professor Michelle Khine created BioENGINE. Khine, a former student entrepreneur herself, says creating a company yields countless advantages. "In every respect it prepared me to be a better researcher and think more about the impact of the work. I wanted my students to have that experience; it's really motivating and very powerful."

Throughout the fall quarter, students attend twice-weekly lectures delivered by established biomedical industry executives, who give them an insider's insight into innovation and incubation, designing for usability, product assessment, regulatory requirements and finding investors. The process emphasizes what Tang calls "the three I's": identifying a problem and its possible solutions, inventing a device and implementing key market-delivery strategies.

"We made sure to teach the things our industry advisers have told us is important in industry," Khine says. "And we make the students actually do the work instead of just reading about it."

Lectures continue through winter quarter, during which time the students also create their prototypes. By spring, the teams are polishing their products and perfecting their pitches, which they deliver to investors at a year-end symposium and awards ceremony.

The top two teams win $15,000 BioENGINE fellowships that fund their work over the summer, allowing them to continue refining their offerings. An additional three teams win a $1,000 design award, which recognizes superior products.

Tang believes the program sparks entrepreneurship at the ideal time in his young students' lives. "When they are in their early 20s, it's the most precious time for them to try something new, to become entrepreneurial," he says. "But they need to be trained in the essential aspects of what it means to start a company."

The program, a partnership with UCI's Applied Innovation, is partially funded through a state grant intended to help speed research and commercialization. The grant requires matching funds, willingly provided by industry executives and entrepreneurs who advocate for the program.

BioAccel, a novel venture fund that targets the medical technology industry, is an active contributor. Randal Schulhauser sits on the BioAccel board and is a program lecturer and mentor. "The world has become much more complex, and it takes a much longer runway to bring ideas out of a university environment and into the commercial area," he says, crediting BioENGINE with creating a pipeline and speeding the process.

"The fact that the teams are pitching for real money in front of real venture capitalists – that's an important differentiator for this program," Schulhauser adds.

IN THE FOLLOWING PAGES, MEET FOUR STARTUPS THAT BEGAN LIFE AS BIOENGINE PROJECTS.

Nearly 600,000 brain surgeries are performed in the U.S. each year. Because surgeons rely on two-dimensional tools that are not patient specific, it's not possible to get a complete view of a patient's brain prior to a procedure.

THE CHALLENGE

TO DEVELOP A SYSTEM TO PROVIDE 3-D MODELS AND VIRTUAL REALITY (VR) ENVIRONMENTS OF THE BRAINS OF EPILEPSY PATIENTS TO AID SURGICAL PLANNING

VOXEL'S SOLUTION

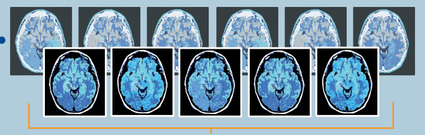
SOFTWARE THAT CAN CREATE 3-D PRINTED AND VR MODELS OF A PATIENT'S BRAIN

Surgeons can interact with the brain model by slicing it and viewing the inside, rotating it and drawing on it. This intuitive tool will assist in surgical diagnosis and planning.

> "VOXEL'S biggest challenge was to combine the worlds of software and biotechnology. We aim to use our surgical planning tools to create a widespread, positive impact in the surgical world."
>
> Prachi Shah
> *CEO, VOXEL*

HERE'S HOW VOXEL'S SOFTWARE WORKS:

1. Data from hundreds of images of a patient's MRI and CT scans are uploaded.



2. Software selects visual information from the scans and uses algorithms to convert the data into calculations for 3-D printing and virtual reality.

3. Calculations are input to produce 3-D printed and/or VR model.

Data for 3-D printing | Data for VR model

3-D printed model of patient's brain, used to plan surgery.

Virtual reality model used for in-depth analysis of patient's brain.

VOXEL team members (l to r): Leslie Fernando, Dishant Donga, Prachi Shah, Natalie Mai, Paul Nguyen

More than 6.5 million people in the U.S. rely on a walking device to assist with their mobility. While the standard underarm crutch is inexpensive and widely distributed, its prolonged use often results in discomfort for the user. The low price of traditional crutches has discouraged most efforts to redesign a more specialized and comfortable device.

THE CHALLENGE

TO DESIGN A CRUTCH COMFORTABLE ENOUGH FOR PROLONGED USE, AND PRICED TO BE COMPETITIVE WITH THE STANDARD CRUTCH MARKET

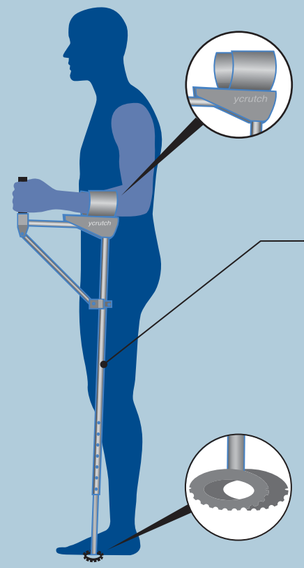
YCRUTCH'S SOLUTION

AN INEXPENSIVE, CUSTOMIZABLE, ERGONOMIC CRUTCH

yCrutch's device includes adjustable features that help redirect weight to reduce muscle strain and minimize discomfort, while allowing for safer use across multiple terrains.

> "The biggest struggle was how many times we were told that this would be 'too hard to bring to market' or how some judges wouldn't want to invest their own money in our product."
>
> Wesley Chiang
> *Founder, yCrutch*

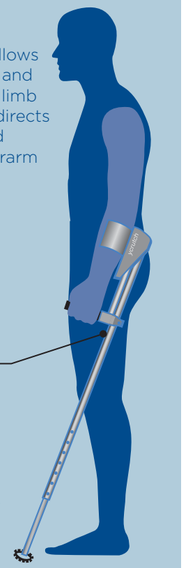
HERE'S HOW YCRUTCH WORKS:



Comfort
Wide-angle arm stabilizer allows for optimization of comfort and stability depending on user limb length. Forearm support redirects stress points to forearm and elbow joint to prevent underarm bruising and slippage.

Customizable
Adjusts to accommodate a range of heights. Forearm bar adjustment can transform yCrutch into a stable walking/support cane.

Balance
Pseudo-soft material provides compression to minimize shock from usage. Ribbed pattern and shape offer a more secure hold on multiple types of terrain.



yCrutch team members (l to r): Shyen Nasseri, Elisa Tran, Brandon Lee, Wesley Chiang

Burn wounds are the fourth most common form of trauma worldwide, and over half a million people seek treatment for burns annually in the U.S. The primary methods to determine burn severity are visual observation and histology; both are only 50 percent accurate.

THE CHALLENGE

TO DESIGN AND BUILD A LOW-COST, HAND-HELD IMAGING DEVICE FOR RAPID AND ACCURATE ASSESSMENT OF BURN INJURIES

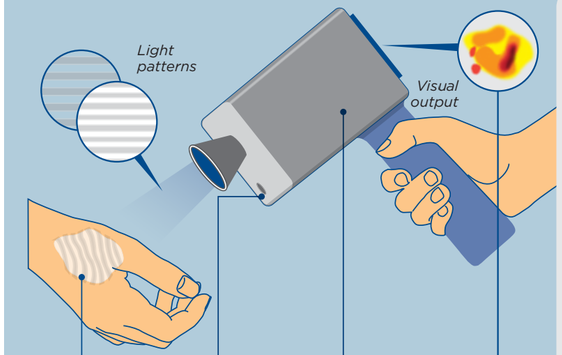
SALUX'S SOLUTION

A HAND-HELD DEVICE THAT CAN RAPIDLY ASSESS BURN WOUNDS

Salux Diagnostic's device, the Vesta Imager, can image and diagnose a burn injury in under five minutes, while also minimizing the risk of misdiagnosis.

> "The time constraint of the class and having only nine months to develop our device was a challenge. There is a definite clinical need for this technology, and it was rewarding to see our device go from a napkin design to prototype development."
>
> Maaikee Kiyoe Pronda
> *Co-founder, data analysis officer, Salux Diagnostics*

HERE'S HOW VESTA IMAGER WORKS:



WHAT ANALYSIS OF LIGHT PATTERNS SHOWS

Light scattering: Identifies changes in tissue structure

Hemoglobin/ tissue oxygenation: Indicates tissue viability

Depth sensitivity: Determines extent of tissue damage

1. A series of 14 light patterns is projected onto the wound area.
2. Camera captures images of each light pattern.
3. Algorithms analyze the images to evaluate the severity of the burn.
4. Color-coded, visual assessment is displayed on the device. Output also can be transmitted to a physician.

Salux Diagnostics team members (l to r): Eashani Sathialingam, Dimple Patel, Akshita Agrawal, Shreya Akkenapally, Kevin Trieu, Maaikee Kiyoe Pronda

Nearly one-in-four (about 7 million) diabetic patients in the U.S. carry a lifetime risk of developing a diabetic foot ulcer, a condition plagued with poor healing, infections and lower limb amputation. A staggering 50 percent of these amputees die within five years of surgery.

THE CHALLENGE

TO DEVELOP A FASTER, SAFER AND LESS EXPENSIVE WAY TO SUCCESSFULLY TREAT DIABETIC FOOT ULCERS

SYNTR'S SOLUTION

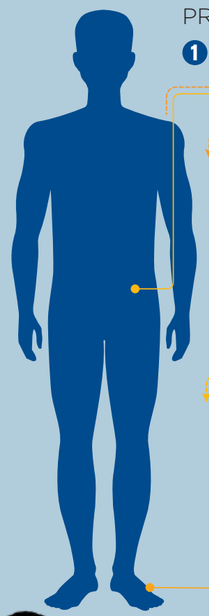
MANIPULATING STEM CELLS TO HASTEN HEALING

Syntr's patent-pending, CD-microfluidic device enables processing of a patient's own body fat to create a stem cell-enriched therapeutic product to help speed the healing of diabetic foot ulcers.

> "Developing a medical device involved the concentrated effort between medical research and engineering to provide an affordable stem cell therapeutic."
>
> Ahmed Zobi
> *Founder/CEO, Syntr Health Technologies*

HERE'S AN OVERVIEW OF THE PROCESS:

PROCEDURE TIME: **UNDER 30 MINUTES**



1. A small amount of body fat is extracted from the patient.
2. Fat is transferred to microfluidic chip.
3. Chip spins in a centrifuge to expedite material flow. Process time is less than 10 minutes.
4. Processed stem cells are packaged into syringe barrel.
5. Patient's own processed stem cells are injected into the wound area.

Stem cells respond to the pressure and shear force created by traveling through the microfluidic chip channels. These forces enrich stem cell populations critical to wound healing while increasing their activity.

Syntr Health Technologies team members (l to r): Hugo Salas, Ahmed Zobi, Justin Stovner, Derek Banyard

ALUMNI AND FRIENDS

ANTEATER SPOTLIGHT

CIVIL ENGINEER HONORED FOR HIS ACHIEVEMENTS

John Labib '94, winner of the 2016-17 UCI Lauds and Laurels Distinguished Alumnus Award in Engineering, is the founder and principal of Los Angeles structural engineering design firm John Labib + Associates. He employs 49 engineers and three administrative professionals and has worked on a number of landmark projects. Labib was inducted last year into the inaugural Samueli School of Engineering Hall of Fame.

Q: You moved to the U.S. from Egypt in the early '90s. Did you come specifically to attend UCI? No, I had come to the U.S. the year before and loved it. I chose UCI because I wanted to stay in Southern California and the school fees were reasonable.

Q: You graduated magna cum laude. Was school easy for you? The study of engineering came easy to me. My struggle was mainly because I had to support myself and raise enough money to pay for school and living expenses without taking any loans. I was working 20 hours for the structural engineering lab, 20 hours as a grader and a full-time 40-hour security job at night. I knew that graduating with honors was going to open up doors for me and cement my future life in the USA. My back was against the wall and there was no looking back.

Q: Who were your mentors at UCI? How did they help you? The late Dr. Medhat Haroun had the most impact. He knew that I had no resources so he helped by giving me as many jobs as I could handle on campus to support myself. His leadership and how sweet and gentle he was made a lasting impact on my life. He was truly a father figure to me during my tenure at UCI.

Q: What was your hardest class? How did you approach it? Thermodynamics! Sorry, but I hated it. It was probably because it was so foreign to what I wanted to become as a structural engineer. I knew I just had to survive and do what it takes to get an A.

Q: What's your fondest memory from your time at UCI? The friendships that I made and my name being called as a magna cum laude while my dad was in the audience.

Q: Your firm has done seismic retrofit and renovation planning for several noteworthy projects, including UCI Hospital. How did it feel to be instrumental in such a large project for your alma mater? It was a true honor to work on the UCI Hospital project. It was that much more special. Felt like I was working on designing my own home. Our office has worked on some fairly significant projects like the Getty Villa renovation, Dodger Stadium, and the Lakers and Clippers training facilities, but there's definitely something special about working on a project at UCI.

Q: What made you decide to open your own firm? I have always known that I wanted to work for myself. I had a great learning experience at my previous firm, and at the time, was managing a small office of 10 engineers. When the opportunity presented itself, I jumped on it and decided to take the risk and start my own firm. That has been the most rewarding decision I have made in my career.

Q: You serve as a mentor to young people. What do you try to impart? I have been mentoring architectural engineering students from Cal Poly San Luis Obispo and would love to do the same for students from UCI. I generally try to help them with design projects, pointing them to practical aspects from the industry as well as instilling in them work ethics.

2017 HALL OF FAME

The Samueli School of Engineering Hall of Fame honors alumni who have made a significant impact in their profession, or in other ways have brought distinction to their alma mater. It was established in 2015 as UCI was celebrating its 50th anniversary. In February, the Samueli School inducted five more alumni into the Hall of Fame.

Mark Christoffels '83, B.S. (Civil Engineering)

Christoffels is the CEO and chief engineer of the Alameda Corridor-East Construction Authority, where he is responsible for a $1.7 billion program of rail-roadway improvements in the San Gabriel Valley of eastern Los Angeles County. The program involves turning typical railroad crossings into three-dimensional thoroughfares, making it possible for vehicles to safely cross the tracks at one level, while trains use another. Due to the program's success, the construction authority is cited as a national model for addressing the impacts of nationally and regionally significant freight rail traffic on local communities. Christoffels has worked in local government for more than 30 years.

Cynthia Stoker Guidry '92, B.S. (Civil Engineering)

Guidry is the deputy executive director of the Planning and Development Group for Los Angeles World Airports (LAWA), where she manages a multibillion-dollar capital improvement program that supports airport operations. With over 25 years of planning, engineering and professional experience working with the city of Los Angeles, she and her team are responsible for planning many of LAX's facilities and programs. Guidry serves on the board of directors for the LA Chapter of Women's Transportation Seminar and the LAX Coastal Chamber of Commerce. She was the first in her family to go to college, and after graduating from UCI, she went on to earn an MBA at Pepperdine University.

Hamid Moradkhani '05, Ph.D. (Civil and Environmental Engineering)

Moradkhani is a professor of civil and environmental engineering, director of the Remote Sensing and Water Resources Lab and fellow of the Institute for Sustainable Solutions at Portland State University. As an ASCE fellow, he has over 25 years of professional experience in analysis, design and management of large-scale water resources systems. Moradkhani has made significant contributions to tackling the grand challenges faced by water resources planners, stakeholders and emergency managers. A distinguished researcher and educator, he is a highly cited author of more than 130 publications and a pioneer in stochastic modeling, data assimilation, cyber innovation and uncertainty-quantification methods used extensively in engineering, Earth science and many other disciplines.

Christopher Schott '73, B.S. (Electrical Engineering)

Schott spent 35 years in the semiconductor business concentrating on failure analysis and yield improvement. As vice president for Integrated Device Technology's Specialty Memory Products division, he was responsible for rolling out the multiport product line and helping IDT become a market leader in that sector. Considered a strategic leader and technical innovator, he also realized success in recruiting and retaining engineering talent, serving as a mentor to many of his employees. Schott was honored with the Distinguished Alumnus Award in 2002 at the Lauds & Laurels Ceremony, where it was noted that he served as co-chair of the first Engineering Week at UCI in 1973.

Joan Wada '85, B.S. (Electrical Engineering)

Wada is an electrical engineer and technical fellow at Boeing, where she has had an extensive engineering career in the defense industry. Wada has made significant systems architectural improvements to submarine acoustic detection on the P-8A anti-submarine warfare program, guidance and control on the Minuteman III missile and a wide range of programs encompassing missiles and ground-command control stations. Wada is the author of 17 awarded patents of next-generation inertial measurement-unit instruments, and she was recognized as the Asian American Engineer of the Year in 2007 by the Chinese Institute of Engineering.

39

alumni have been inducted into the Hall of Fame since it was established in 2015.

UNTAPPED TALENT

PARTNERSHIP CREATES A NATIONAL MODEL FOR STEM PIPELINE

LORI BRANDT DEBBIE MORALES

Previous page: Seven community college students spent half their summer at UC Irvine as paid UCI/Base 11 fellows, working in teams of two to build quadcopters. Pictured, from left, are Lawrence Lawson (LA Southwest College), Kasia Sayles (Chaffey College), Mikaela Quintos (Skyline Collage), Maria Hernandez (Santa Monica College), Noel Lam (Pico Rivera College) and Breanna Allen (Henry Ford College).

MARIA HERNANDEZ GREW UP IN IN EAST LOS ANGELES, RAISED BY HER MOTHER AND GRANDMOTHER. One of her fondest childhood memories is of her mother singing to her in Spanish, a sort of math equation lullaby. "Two plus two is four, four plus four is eight," and so on.

Hernandez wonders if that's why she has always liked math. In elementary school, she participated in math competitions, and in high school, the academic decathlon, where she earned the school's top math score. Now a third-year student in Santa Monica College's science, technology, engineering and math (STEM) program, Hernandez spent seven weeks at UC Irvine this summer as a Base 11 fellow, and she plans to apply to the Samueli School of Engineering once she is done with her prerequisites. "I really want to work with airplanes, designing aircraft and hopefully spacecraft, too. I'd like to work for NASA or Boeing," says the ambitious 21-year-old.

"IF WE CAN ENGAGE STUDENTS IN HIGH SCHOOL, THEN GIVE THEM A PATHWAY TO COMMUNITY COLLEGE AND A FOUR-YEAR UNIVERSITY THAT LEADS TO A CAREER OR ENTREPRENEURSHIP, WE'LL BE ABLE TO GO A LONG WAY TOWARD SOLVING THE STEM TALENT SHORTAGE IN THIS COUNTRY."

This young Mexican American woman is exactly the type of student the Samueli School is working to recruit for its STEM talent pipeline: low resource, high potential and underrepresented in STEM fields.

"Our goal is to broaden the participation of students and professionals in STEM, and engineering in particular," says Sharnnia Artis, assistant dean of the Samueli School's Office of Access and Inclusion, who is part of the team leading the school's outreach effort. "Most tech companies are still male dominated. In order to meet the needs of the STEM workforce, we have to tap into a different population. We want to see more women and students of color pursuing engineering."

Based on its highly successful freshman experiential engineering course, the Samueli School has developed a variety of STEM outreach programs that feature hands-on, project-based education for students in middle school, high school and community colleges. For most, these programs are their first exposure to engineering disciplines.

Indeed, Hernandez had no idea what engineering was until she started watching "The Big Bang Theory" and grew curious about the profession of one of the characters: Howard, the engineer. "They always made fun of him on the show, but he did stuff for NASA and I thought that was really cool," she says. "Most of my friends' parents were immigrants. There were mechanics and electricians in my community, but that is not engineering."

Thanks to Base 11, more students like Hernandez are experiencing STEM fields. The non-profit organization is a workforce and entrepreneur accelerator that connects employers, academic institutions and entrepreneurial opportunities with high potential, low-resource students who have shown interest and talent but lack the access and means needed to realize their potential. Base 11 President Landon Taylor explains: "We are committed to solving the growing STEM talent crisis in this country fueled by the underrepresentation of women and ethnic minorities."

Together, Base 11 and the Samueli School are building a STEM pipeline ecosystem. "We've taken our experiential learning curriculum and turned it into a national model for engaging these students in STEM fields," says Gregory Washington, the Stacey Nicholas Dean of Engineering.

A number of companies and organizations are supporting the pipeline effort, including the Dassault Systèmes U.S. Foundation, Deloitte Foundation, Northrop Grumman, Western Digital, Broadcom and Boeing, among others. The engineering school has trained teachers from three community colleges and one high school to replicate the project-based approach in their own schools.

In addition, UCI's Samueli School established a collaboration with the Santa Ana-based Samueli Academy, a charter high school that aims to provide a transformational learning environment to the community's underserved and foster teens. The Samueli School worked with the academy on experiential learning curricula and academic exchanges.

Last spring, UCI's Washington and Base 11's Taylor attended the STEM connector's Global STEM Talent Summit in Washington, D.C., to spread the news of their pipeline model with others from around the country.

Says Washington, "We've been sharing our model with others as a way to scale up this effort."

Over the past two years, Base 11 has gifted more than $2 million to help the Samueli School refurbish labs, purchase equipment and create the Autonomous Systems Academy, where students learn the basics of aerospace design, computer-aided design, 3-D printing, basic electronics and fabrication techniques through a series of mini projects. Each of those mini projects is a necessary component of the final capstone project: a fully operational unmanned aerial vehicle, or drone.

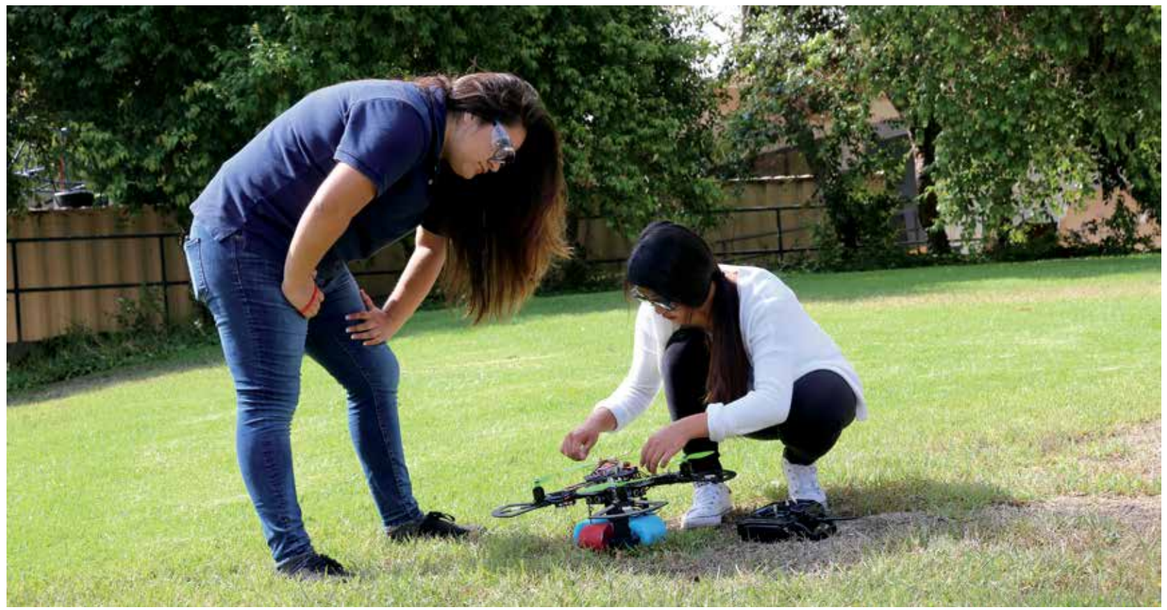
"Our strategy is to create integrated partnerships between industry, academia and philanthropy in order to transform these high-potential, low-resource students into that talent," says Base 11's Taylor. "UCI has been an incredible partner in alignment with that vision. If we can engage students in high school, then give them a pathway to community college and a four-year university that leads to a career or entrepreneurship, we'll be able to go a long way toward solving the STEM talent shortage in this country."

To date, 24 community college students have completed a UCI/Base 11 program, and over 1,000 UCI undergraduates have used the equipment in the academy.

Hernandez has taken advantage of two of the UCI/Base 11 programs. First as an academic-year intern, she came to UCI on alternating Saturdays over eight months and learned how to program with Raspberry Pi. Her project, a remote door-unlock system, used facial recognition technology to identify a person at the door; it then sent a notification and image to her smartphone and enabled her to unlock the door remotely. Next, she applied and earned a paid spot as a summer fellow in the Autonomous Systems Academy. She teamed with Mikaela Quintos from Skyline College in San Bruno, and they built a quadcopter.

Hernandez has big plans for sharing her ideas and talent. Beyond her goal of becoming an engineer, her ultimate dream is to build an engineering school in Mexico. "I'd like to do something for my community, give people the opportunity to continue in their education, because so many like my mother had to stop school and go to work," she says.

Maria Hernandez (left) and Mikaela Quintos prepare their drone for a test flight.



TEAM SCIENCE

TRANSFORMATIVE GIFT LAYS THE FOUNDATION FOR INTERDISCIPLINARY RESEARCH BUILDING

ANNA LYNN SPITZER

PHOTO: SMITHGROUP JJR

THE SAMUELI SCHOOL HAS LONG LOOKED TO MULTIDISCIPLINARY RESEARCH AS A KEY TO SOLVING SOCIETY'S GLOBAL GRAND CHALLENGES.

Now the quest to advance cross-disciplinary collaborations is a step closer to reality, thanks to a generous donation from a philanthropic Orange County family. With its initial $30 million commitment last spring, the Samueli Foundation set in motion the construction of a new building where science and engineering research will converge. An additional $9 million gift from the foundation, made over the summer, will fund efforts to bring at least 35 new engineering faculty on board over the next five years.

The Interdisciplinary Science and Engineering Building, a proposed 180,000 square feet of laboratories, classrooms, offices, conference rooms and flexible open space is expected to break ground next spring and open its doors in late 2020. It will provide space for collaborative research in engineering, physical sciences and information and computer sciences, enabling UC Irvine researchers to work on key innovations across disciplinary boundaries with colleagues in other fields.

The Samueli Foundation gift allowed UCI to leverage $50 million from the UC Office of the President and an additional $40 million in campus funds to construct the building.

Henry Samueli and his wife, Susan, *(pictured right)* have been longtime UCI benefactors. The School of Engineering received a $20 million gift from the couple in 1999 and was renamed for Henry Samueli, who cofounded the semiconductor company Broadcom. He has served as a distinguished adjunct professor of electrical engineering and computer science and as a UCI Foundation Trustee. The Susan Samueli Center for Integrative Medicine at the UCI School of Medicine was established in 2001 with a $5.7 million gift.

Samueli said that he and his wife "are deeply committed to supporting science, technology, engineering and mathematics (STEM) education at all levels along the learning pipeline, from kindergarten through higher education."

He added: "Addressing today's grand challenges in society requires collaborative research across a multitude of disciplines, aligning with our STEM ecosystem concept. We hope this gift to UCI can be a catalyst for accelerating cross-disciplinary research and scientific innovations that benefit society."

Samueli School Dean Gregory Washington worked closely with the couple to secure the most recent transformative gift. "We envision collaborations that will directly impact society," said Washington. "The major challenges of the planet are at the interfaces of disciplines. We're bringing together resources and faculty to really focus, and help mitigate and solve these challenges."

Engineering will oversee 50 percent of the building's space, with the remainder allocated to physical sciences and information and computer sciences. Graduate students from all three areas will work together in laboratories and offices.

According to Washington, three key areas of research will reside in the new facility; water, biological/chemical and data sciences projects will be the first beneficiaries of the multidisciplinary collaborations enabled by the building. "We're going to bring together key people from engineering, physical sciences and information science in order to have more synergy among these groups," he said.

Potential ideas include developing chemical and material sensors to better diagnose and treat cancers; using big data, environmental engineering and organic chemistry to improve water supply or solar energy; and having cybersecurity coders and mathematicians collaborate on military or medical challenges.

> "Addressing today's grand challenges in society requires collaborative research across a multitude of disciplines, aligning with our STEM ecosystem concept."

Computer sciences expertise will be key, said Marios Papaefthymiou, dean of the Donald Bren School of Information & Computer Sciences.

"Everyone wants to work with us, because we enable what medicine does, we enable what social sciences does, and physical sciences and engineering – you name it," he said. "We're thrilled to be part of this game-changing piece of UCI."

The structure will be located in the heart of the campus's engineering and sciences quad, adjacent to Bison Avenue and East Peltason Drive. Preliminary plans for the building include seven to eight floors of space, with an emphasis on meeting spaces and contemporary laboratories.

"What that means is flexibility, the ability to accommodate a wide range of research endeavors," said UCI Assistant Vice Chancellor and Campus Architect Brian Pratt. "We're going to build labs that can be easily adapted – a kind of plug-and-play approach."

The labs also will be scalable, adjusting easily to accommodate a huge range of instruments and equipment. "As Dean Washington has said, the goal is to have a building that lends itself to solving society's great challenges," Pratt added. "Some ideas for research will come from places no one has thought of yet, and we want to be able to accommodate that. We don't want to make the space too tailored; we want to keep it flexible."

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The building will encompass a host of sustainable features, including energy-efficient systems, smart controllers, sensors and design schemes for reducing lighting energy requirements and low-flow plumbing fixtures. There will be a number of naming opportunities for donors, including auditoriums, building wings, laboratories, terraces and conference rooms.

"This building will be a focal point of interdisciplinary research for our campus," summed up Washington. "The generous gift from Susan and Henry Samueli is making this possible."

JOIN THE RING ROAD SOCIETY

PHOTO: SMITHGROUP JJR

TACKLING SOCIETAL GRAND CHALLENGES FACING THE WORLD WILL REQUIRE INNOVATIVE APPROACHES FROM MULTIPLE DISCIPLINES. UC Irvine has a well-known history of nurturing interdisciplinary scholarship and research, with its Ring Road design providing a circle of schools facing each other. Now, the new Interdisciplinary Science and Engineering Building will be constructed along the ring to advance collaborations for finding solutions to complex regional and global problems.

UCI alumni and friends who want to be part of this effort from the ground up can join the Ring Road Society. A gift of $25,000 or more toward facilities and equipment will provide you with membership in an exclusive group of advocates who believe in the Anteater interdisciplinary tradition and want to see the university maintain its position at the forefront of addressing scientific and technological challenges.

We look forward to your support for this new building and thank you for your dedication to the Samueli School of Engineering.

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