BUILDING ENGINEERS

Ira A. Fulton Schools of Engineering | Arizona State University Fall 2016

VROOM

Ford Motor Company's engines keep ASU interns revved for future automotive careers 26

ASU IRA A. FULTON SCHOOLS OF engineering
ARIZONA STATE UNIVERSITY

Inside

IRA A. FULTON SCHOOLS OF engineering
ARIZONA STATE UNIVERSITY

Published by the Ira A. Fulton Schools of Engineering, Arizona State University

PO Box 879309 Tempe AZ 85287-9309

engineering.asu.edu

To be added to our mailing list, visit: engineering.asu.edu/mailing-list.

We love to hear from our alumni!
Send us your updates:
engineering.asu.edu/alumni-updates

facebook.com/asuengineering

twitter.com/asuengineering

instagram.com/fultonengineering

goo.gl/IWx4zd

Contributors

Monique Clement
Marc Collins
Kristin Bergeson Gasser
Terry Grant
Erika Gronek
Jessica Hochreiter
Jessica Jaskiewicz
Joe Kullman
Jake Kupiec
Stephanie Mabee
Robert Mayfield
Steve Ryan
Rose Serago
Hayden Taylor
Anna Wales
Erik Wirtanen
Pete Zrioka

Cover story
Mechanical engineering senior Troy Buhr knew he wanted an internship with Ford and pulled out all the stops to get one. "I attended all of the career fairs and info sessions," he said. "I spoke to as many industry reps as possible – I think I was usually the last one to leave."

See more photos and videos online.

Shielding homeowners from energy loss

An ASU-led research team was awarded a $2.19 million grant to develop energy conscious technology aimed at lowering energy costs and increasing comfort for homeowners. The grant is part of a $31 million investment in an Advanced Research Projects Agency-Energy (ARPA-E) program to develop window coatings and windowpanes to increase the energy efficiency of single-pane windows. The program, dubbed Single-Pane Highly Insulating Efficient Lucid Design, or SHIELD, granted awards to 14 universities, laboratories and businesses to create technologies that offer an alternative to complete window replacement.

"The SHIELD program illustrates ARPA-E's commitment to supporting transformational technologies," said ARPA-E Director Ellen D. Williams in a press release. "By creating novel materials to retrofit existing single-pane windows, SHIELD technologies can dramatically improve building efficiency and save energy costs for building owners and occupants."

One such technology poised to improve efficiency and reduce costs is being developed by electrical engineering Assistant Professor Zachary Holman and his co-principal investigators Associate Professor Chris Hogan and Assistant Professor Eric Toberer of the University of Minnesota and the Colorado School of Mines, respectively. The team of researchers is working on an approach that employs a novel delivery system to apply three layers of particulate coatings to windowpanes.

Their system sprays nanoparticles suspended in a gas — an aerosol — on to windowpanes during manufacturing to form a coating. The coatings not only improve thermal insulation, but also reinforce the mechanical strength of the pane, prevent condensation and provide a degree of soundproofing. These features were suggested by ARPA-E as a result of market research, according to Holman.

Holman noted that the aerosol process, which differs from the commonly used wet chemical approach to apply window coatings, is estimated to only cost $1 per square meter more than existing panes. Holman and collaborators anticipate these windowpanes could save each homeowner approximately $100 annually in energy expenses.

Single-pane windows, commonly found in homes built before the 1980s, can represent up to 20 percent of a home's energy loss. In addition to being expensive, double-pane windows are also known to fail, as the seal between the panes leaks, causing condensation and hampering their efficiency.

Holman posits that thermally insulating single-pane windows would actually be better for homeowners than their dual-pane counterparts.

While the project draws on Holman's research experience, the outcome has potential to impact him personally as well. Holman and his research collaborators all live in homes with single-pane windows. Holman's home, built in 1930, still features its original, single-pane wavy glass windows. As to be expected with any 80-year-old structure, the windows have seen better days, according to Holman.

"The caulking is old and failing, some panes are cracked and we'd really like to replace them all, but my wife digs the wavy glass. I like it, too — it casts great shadows in the morning," added Holman.

He's acquired every type of wavy glass made in the U.S., and all are largely the same, providing no thermal insulation or soundproofing. Through his work on this project, Holman hopes technology will emerge that gives homeowners more options when it comes to window replacement.

"This is a unique project in that my collaborators and I are not only interested in the science and engineering outcomes, but we also have a vested interest in developing this technology for our own use," said Holman.

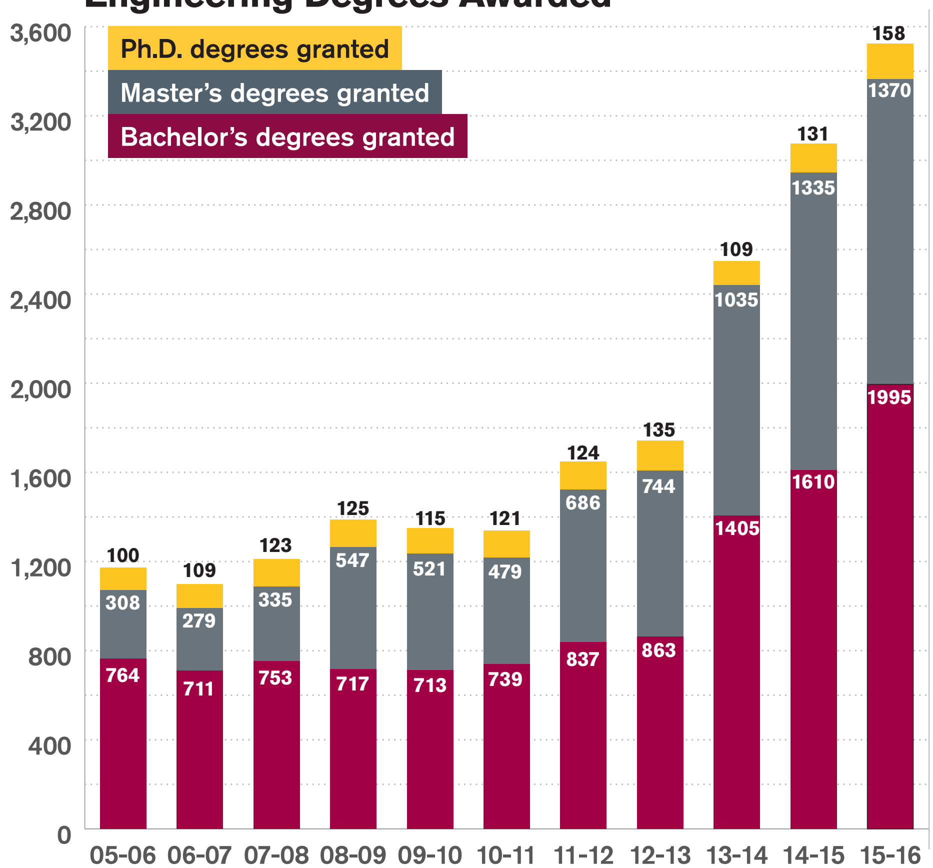
This award comes on the heels of Holman and graduate research associate Peter Firth establishing a company to commercialize the aerosol deposition technology they developed. Called LN Tech, the business recently landed a $45,000 investment after Firth's successful pitch at the New Venture Challenge entrepreneurship program. Geared toward graduate students, the inaugural event was jointly held by the Ira A. Fulton Schools of Engineering and ASU's W. P. Carey School of Business.

Though Firth pitched LN Tech as a company aimed at improving displays such as TV screens or computer monitors as well as antimicrobial fabrics, in light of this award, they now have a renewed interest in the window coating market.

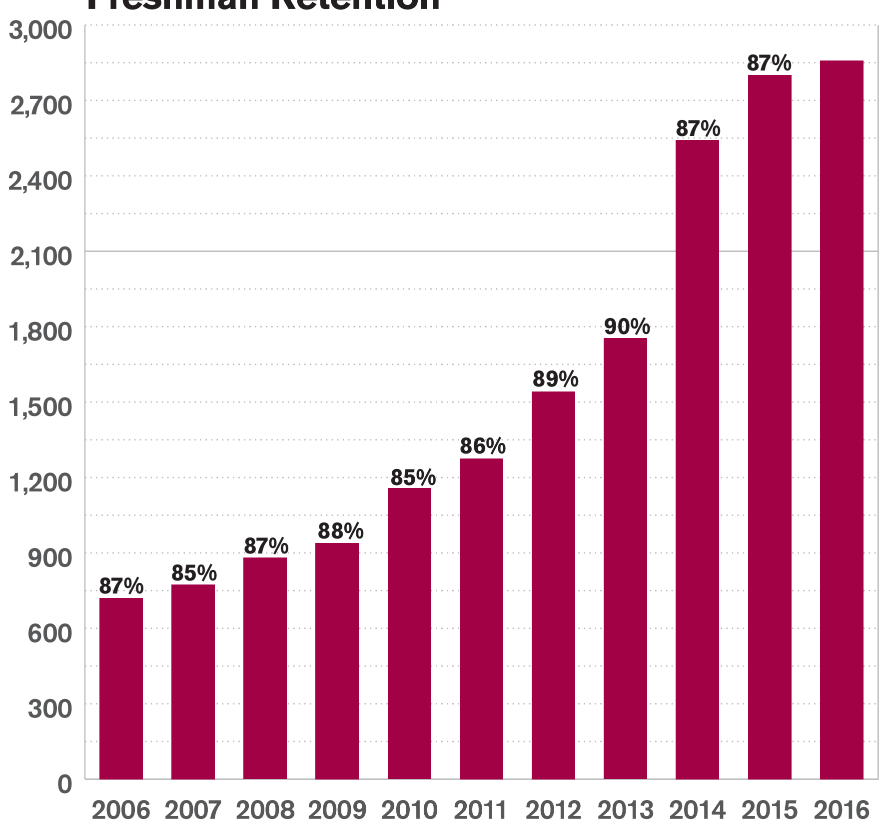
Building engineers: Data snapshot

Focused on Student Success

Engineering Degrees Awarded



Freshman Retention



Fall 2016 enrollment (estimated)

20,275

Degrees granted 2015-2016 (estimated)

3,523

Fall 2016 first-time freshmen (estimated)

2,859

Fulton Schools students in Barrett, the Honors College

30%

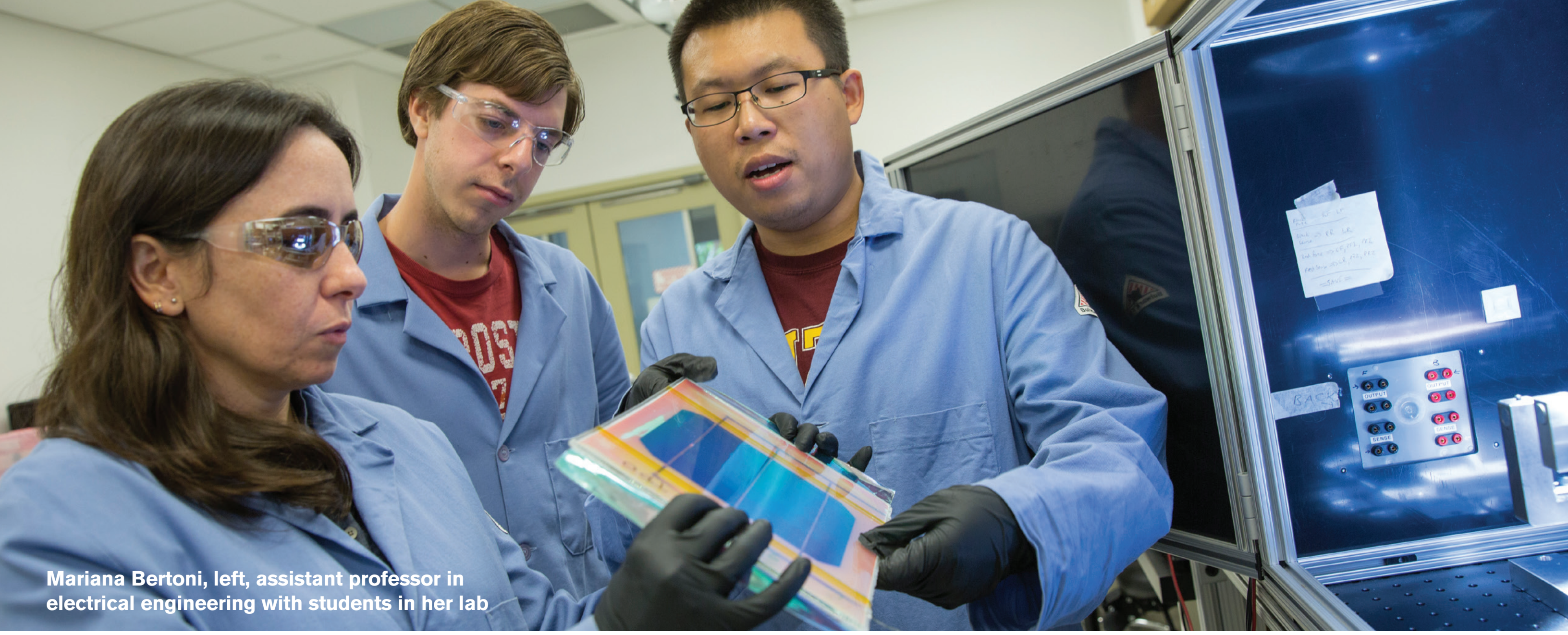
Undergraduate Programs

23

Graduate Programs

39

Two campuses and online



Mariana Bertoni, left, assistant professor in electrical engineering with students in her lab

We are leading critical national initiatives

Four Engineering Research Centers

CBBG NSF Engineering Research Center with partners Georgia Tech, New Mexico State and UC Davis

QESST NSF-DOE Engineering Research Center with partners MIT, Caltech, Georgia Tech and others

Partner on two NSF Engineering Research Centers: NEWT with Rice University, Yale and UTEP and FREEDM Systems with NC State University, Florida State University, Florida A&M University and Missouri S&T

Eight NSF Industry/University Cooperative Research Centers (I/UCRCs): PSERC, Connection One, SenSIP, WET, Center for Embedded Systems, CASCADE, BRAIN and Center for Efficient Vehicles and Sustainable Transportation Systems

Two NSF Integrative Graduate Education and Research Traineeship (IGERTs)

Six Multidisciplinary University Research Initiatives (MURI) awards; 11 total since FY2005

$18 million from USAID to establish the U.S.-Pakistan Centers for Advanced Studies in Energy (USPCAS-E) to improve power production in Pakistan

HEEAP, Higher Engineering Education Alliance Program (Intel, Siemens) $20M cash and more than $50M in-kind donations by academic, government and industry partners

Young investigator awards

From FY2014 to FY2016, junior faculty in the Fulton Schools of Engineering have received 33 young investigator awards from NSF CAREER, AFOSR YIP, DARPA YFA, NASA and NIH Directors/Development.

CAREER Awards
Jennifer Blain Christen (2016)
Candace Chan (2016)
Srabanti Chowdhury (2015)
Georgios Fainekos (2014)
Jingrui He (2016)
Shawn Jordan (2014)
Vikram Kodibagkar (2014)
Oliver Kosut (2015)
Mary Laura Lind (2014)
Ross Maciejewski (2015)
Jagannathan Rajagopalan (2015)
Lalitha Sankar (2014)
Sarah Stabenfeldt (2015)
Pingbo Tang (2015)
Sefaattin Tongay (2016)
Pavan Turaga (2015)
Liping Wang (2015)
Shimeng Yu (2016)
Ming Zhao (2016)

AFOSR YIP
Panagiotis Artemiadis (2014)
Srabanti Chowdhury (2015)
Ximin He (2016)
Paulo Shakarian (2015)
Yu Yao (2016)

DARPA YFA
Panagiotis Artemiadis (2014)
Spring Berman (2014)
Srabanti Chowdhury (2015)
Yang Jiao (2014)
Jennifer Kitchen (2016)
Samira Kiani (2016)

NASA Early Career Faculty Space Tech Research Grant
Yuji Zhao (2016)

NIH Director's New Innovator Award Program
Sarah Stabenfeldt (2015)

NIH Training/Career Development
Karmella Haynes (2015)

Research Awards

$99.4M

Research Expenditures

$98.34M

Invention Disclosures (FY2016)

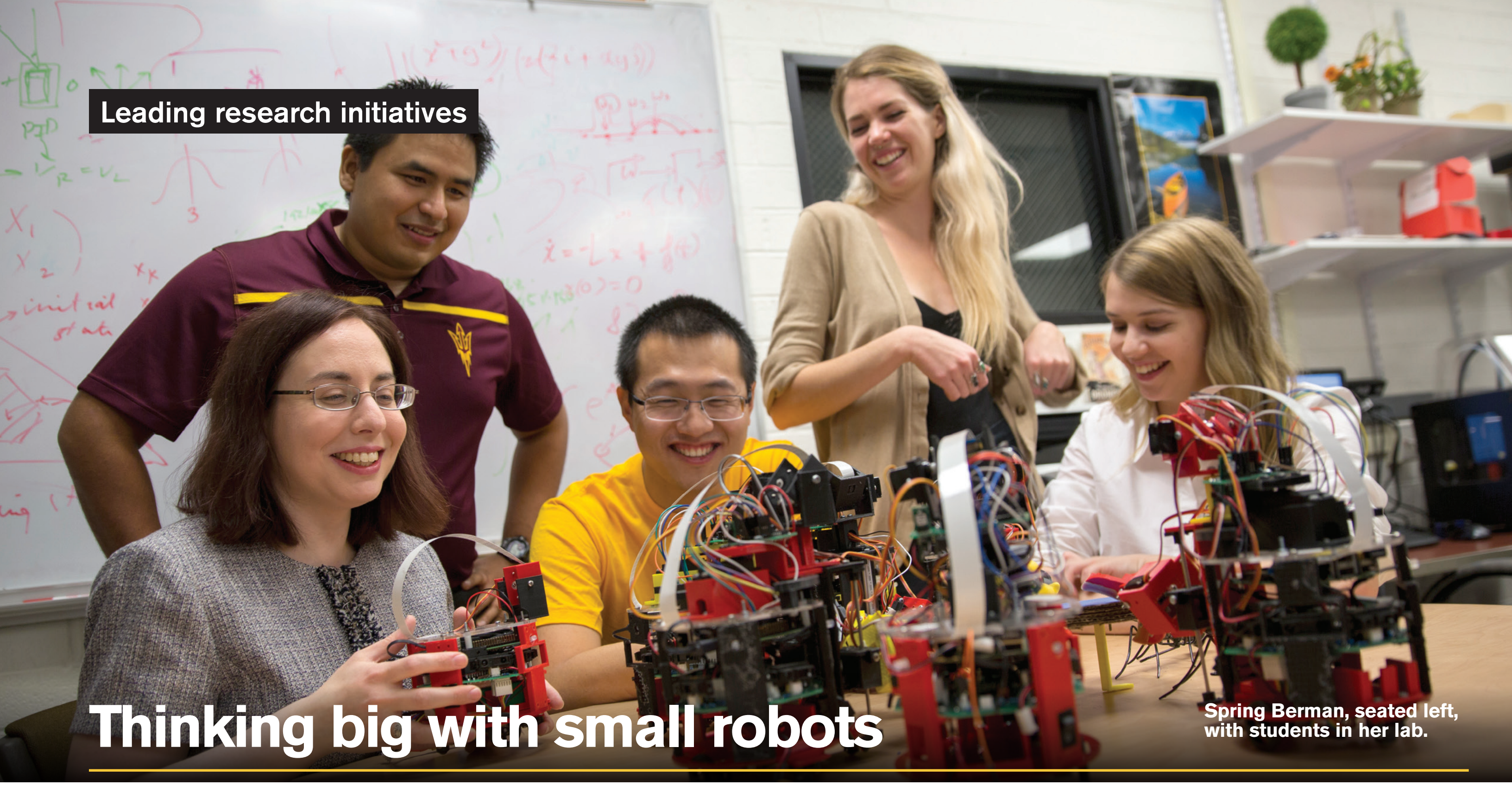
153

Undergraduates Conducting Research

1000+

Get our latest news:

fullcircle.asu.edu



Thinking big with small robots

Spring Berman, seated left, with students in her lab.

Spring Berman doesn't have the droids you're looking for. Instead, she's developing droids that can look for you.

That might sound ominous, but rest assured, the assistant professor of mechanical and aerospace engineering at the Ira A. Fulton Schools of Engineering is working on robots that go where humans can't and work how humans often won't — cooperatively. She's developing techniques for modeling, optimization and control of very large collectives of robots, or robot swarms. Someday, these conglomerates of small autonomous agents may be used in search and rescue operations, scouring remote wildernesses for a lost hiker or looking for survivors after a tornado or earthquake. They may even aid in exploration or inspection tasks as well.

She recently received a $170,000 a year, three-year Office of Naval Research Young Investigator Program award, which she'll use to develop methods for deploying collaborative, coordinated robot swarms that can adapt to a given environment.

To control robots that can adjust their behavior in response to their environment, Berman looks to the natural world for inspiration. Collective animal behavior, evident in schools of fish, flocks of birds or herds of sheep, is characterized by the lack of centralized leadership. Instead, individual animals within a collective use information about their environment or their neighbors to determine where to go — be that toward food or away from a predator.

"The ability to coordinate a lot of different agents, especially in the face of uncertainty or failure, is going to be very important going forward," says Berman. "Biology really excels at this. If a particular strategy has been used for millions of years, there's a reason for it."

Borrowing from — and giving back to — nature

While Berman borrows from nature's tried and true strategies, she imagines applications that could in turn be used to benefit the natural world. She sees potential for using robot collectives in environmental conservation efforts, such as planting trees, monitoring forest fires or even providing persistent surveillance of an area to deter poachers.

Robot swarms could also be used to gather data to track a variety of environmental factors, from the population of a threatened or endangered species to temperature levels or even the state of polar ice caps.

"With a swarm of robots you can obtain an enormous amount of data from many points of view — in the air, on the ground, underwater — and observe how the information changes over time," says Berman.

Making robot swarms that work together by gathering and sharing information isn't her sole endeavor, either. She also wants to develop ways for them to assist one another physically through cooperative manipulation of objects.

"We're studying ants that have developed robust and efficient ways to move food items in teams around obstacles. If we could fully automate this type of problem solving, it could be really valuable for transport, assembly and construction in places that are difficult for humans to access," she says.

Berman uses sophisticated 3D modeling programs and other software tools to simulate robots performing a desired task, such as cooperatively moving an object. The simulations can be reset and altered at a lower cost and in less time compared to running numerous experiments with real robots.

This research could someday lead to scenarios in which a group of robots cooperatively sift through rubble and debris in the wake of an earthquake to find survivors. Add airborne drones to that equation, and you have a level of teamwork and coordination unattainable with human assets.

"You could deploy a heterogeneous swarm of different vehicles working toward a common goal and supporting one another from different locations," says Berman.

Drone swarms could be used for other humanitarian missions as well, such as detecting land mines or delivering much-needed supplies to disaster-stricken areas.

How bacteria can produce electricity, treat wastewater

César Torres, left, with FURI undergraduate researcher Mikaela Stadie.

What if the bacteria found in wastewater could power the water's own purification system?

Chemical engineering professor César Torres is exploring this possibility through research in microbial fuel cells (MFCs), supported in large part by a $1,900,000 grant from the Department of Defense.

An MFC is a bio-electrochemical device that converts the power of respiring microorganisms into electrical energy. Specifically, MFCs contain anode-respiring bacteria (ARB) that can produce electricity when electrons from wastewater organics are transferred to an anode.

"In this system organic compounds can be removed from water, while electrical current is simultaneously produced," said Torres, who earned his doctorate in environmental engineering from ASU in 2009.

The electrical current in MFCs can be used to produce hydrogen peroxide.

"This oxidant is rarely used in wastewater treatment because of its high cost, but MFCs allow on-site hydrogen peroxide production using energy from wastewater," said Torres.

Torres is conducting this research in conjunction with Bruce Rittman, a Regents' Professor and director of the Swette Center for Environmental Biotechnology in the Biodesign Institute and Konstantinos Tsakalis, an electrical engineering professor.

Powering sensors in the ocean's depths

Two additional grants from the Department of Defense's Office of Naval Research further the Torres Lab's exploration in MFC research. Rachel Yoho, a biological design doctoral student in the Torres Lab, is leading an effort to identify key proteins used in ARB to produce electrical currents. This portion of the research is supported by a $450,000 grant.

Another $400,000 grant supports research in the use of MFCs as power sources for sensors that collect data (like temperature and oceanic current flows) critical to efficient navigation.

These sensors require a self-sustainable power supply since batteries are not feasible for long-term use at the bottom of the ocean.

"MFCs produce low power densities, but enough to power sensors in remote locations where a continuous supply of fuel is possible due to the organic compounds found in nature," said Torres.

Improving wastewater treatment technologies

Torres is also leading an effort to better understand microbial processes in municipal wastewater sludge treatment through the use of ARB.

Microbial respiration can be measured in combination with electrical currents in MFCs, which provides insights into the microorganism's behavior.

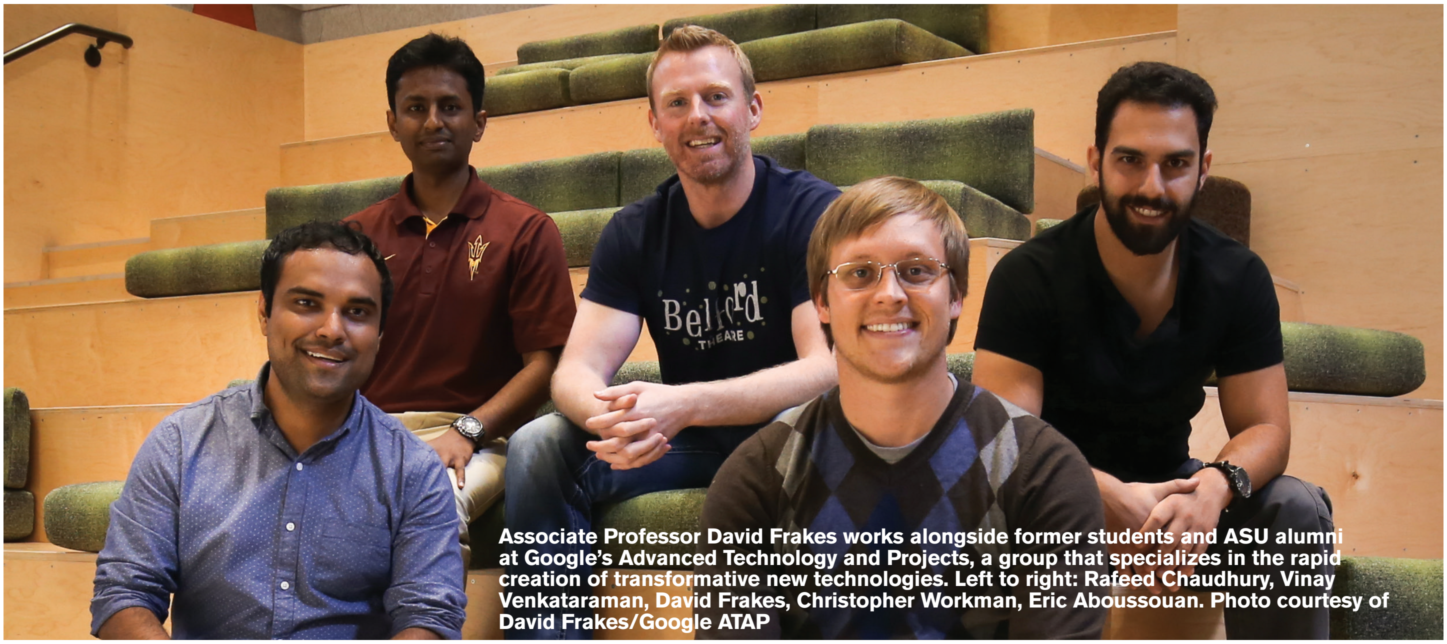
This allows the MFC to become an analytical tool for measuring the rate at which ARB respire, providing a more accurate and time-sensitive measurement of microbial processes related to hydrolysis than current methods.

The research is funded with a $333,000 grant from the National Science Foundation (NSF) and led by Torres and Steven Hart, an environmental engineering doctoral student in the Torres Lab and recipient of an NSF Graduate Research Fellowship.

Simple, natural solutions to complex problems

Torres' research in this area as a principal or co-principal investigator has been funded in excess of $4 million. He has published more than 30 peer-reviewed journal articles related to microbial cell research.

"There are many applications envisioned within the field of microbial electrochemistry, yet there are many aspects of these microorganisms that we do not yet understand," said Torres. "It is a field in which science and engineering make progress together and depend on each other — making it both challenging and exciting."



Associate Professor David Frakes works alongside former students and ASU alumni at Google's Advanced Technology and Projects, a group that specializes in the rapid creation of transformative new technologies. Left to right: Rafeed Chaudhury, Vinay Venkataraman, David Frakes, Christopher Workman, Eric Aboussouan. Photo courtesy of David Frakes/Google ATAP

Frakes leads Google ATAP project, teams up with former students

What began with a series of grants to advance research in computer vision quickly culminated in a relocation to Google's main campus for Associate Professor David Frakes.

In 2015, Frakes moved to Mountain View, California, to become a technical project leader in Google's Advanced Technology and Projects group (ATAP).

He oversees ATAP's Mobile Vision program composed of 16 full-time researchers. The team includes three ASU graduates, two of which Frakes supervised at the graduate level, and another of Frakes' former students has also joined a different team at ATAP.

All four are alumni of the Fulton Schools where Frakes holds a joint appointment in the School of Biological and Health Systems Engineering and the School of Electrical, Computer and Energy Engineering.

Google ATAP operates in what Frakes describes as a "pressure cooker" for big ideas — meaning tangible results must be obtained within two years or a project is shelved to make room for the next big project.

Former students become coworkers

ASU alumni Eric Aboussouan and Christopher Workman work alongside Frakes, their former professor and graduate supervisor, in the Mobile Vision program.

"It's very gratifying not only to see your students go on and do great things, but also to have a relationship with them where they want to keep working with you professionally," says Frakes.

Aboussouan, a lead engineer at Google ATAP, graduated from ASU in 2011 with a doctoral degree in electrical engineering.

Workman began conducting research in ASU's Image Processing Applications Laboratory, led by Frakes, during his sophomore year. He went on to earn bachelor's degrees in biomedical engineering and biochemistry in 2014, and graduated with a master's degree in biomedical engineering under Frakes' supervision in 2015.

"Throughout [my time in Frakes' lab], he challenged me to approach the solutions to problems people face in creative ways," says Workman. He credits the "inquisitive way of thinking" championed by Frakes with enabling the smooth transition into his position as a prototyping engineer.

Strong relationships with students have characterized Frakes' career. He has mentored 20 doctoral students, 32 master's students and 207 undergraduates — including students pursuing undergraduate research as part of capstone senior design projects, the Fulton Undergraduate Research Initiative and Barrett, the Honors College — since joining ASU in 2008.

He currently supervises seven doctoral and five master's students who he says have been "exceptional" in ensuring that his lab and research efforts at ASU move markedly forward during his two years at Google ATAP.

"My lab is not slowing down, it's just being managed differently," says Frakes who meets with his students remotely every week.

Proof of his success at ASU is seen in a recent award from the National Science Foundation. This research, which began in June, will advance the development of a first of its kind sensor to take measurements critically important in treating cardiovascular diseases.

Frakes admitted it was a hard decision to remove himself geographically from his lab at ASU and current projects, but added, "Everything that I learn and every way that I grow during my time at Google ATAP I get to bring back to ASU faculty and my students."

Materializing the ghost in the machine

Despite the excitement of being able to manipulate virtual fingers, or even fingers attached to a functioning prosthetic device, it is not the same as feeling like the device is part of your own body.

Research by Associate Professor Bradley Greger's team, published in the March issue of the Journal of Neural Engineering, is seeking to establish bidirectional communication between a user and a new prosthetic limb that is capable of controlling more than 20 different movements.

The paper was co-authored by Greger and Tyler Davis, Heather Ward, Douglas Hutchinson, David Warren, Kevin O'Neill III, Taylor Scheinblum, Gregory Clark, Richard Normann, all at the University of Utah. Greger, a neural engineer, joined the School of Biological and Health Systems Engineering at ASU three years ago.

In the nervous system there is a "closed loop" of sensation, decision and action. This process is carried out by a variety of sensory and motor neurons, along with interneurons, which enable communication with the central nervous system.

The published study involved implanting an array of 96 electrodes for 30 days into the median and ulnar nerves in the arms of two amputees. The electrodes were stimulated both individually and in groups with varying degrees of amplitude and frequency designed to determine how the participants could perceive the stimulation. Neural activity was recorded during intended movements of the subjects' phantom fingers and 13 specific movements were decoded as the subjects controlled the individual fingers of a virtual robotic hand.

Bradley Greger

The motor and sensory information provided by the implanted microelectrode arrays indicate that patients outfitted with a highly dexterous prosthetic limb controlled with a similar, bidirectional, peripheral nerve interface might begin to think of the prosthesis as an extension of themselves rather than a piece of hardware, explained Greger.

"Imagine the kind of neural computation it takes to perform what most would consider the simple act of typing on your computer," says Greger. "We're moving the dial toward that level of control."

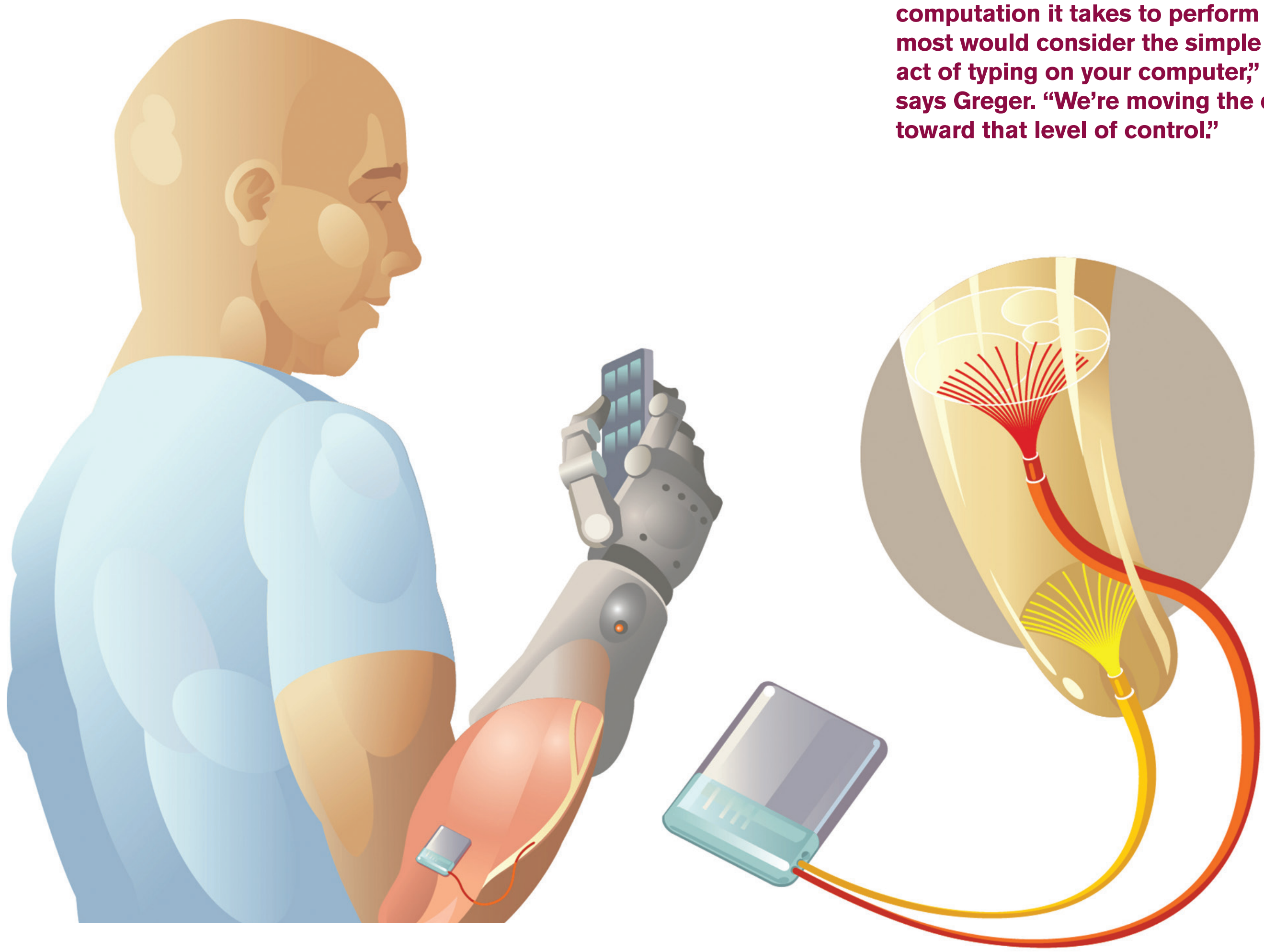
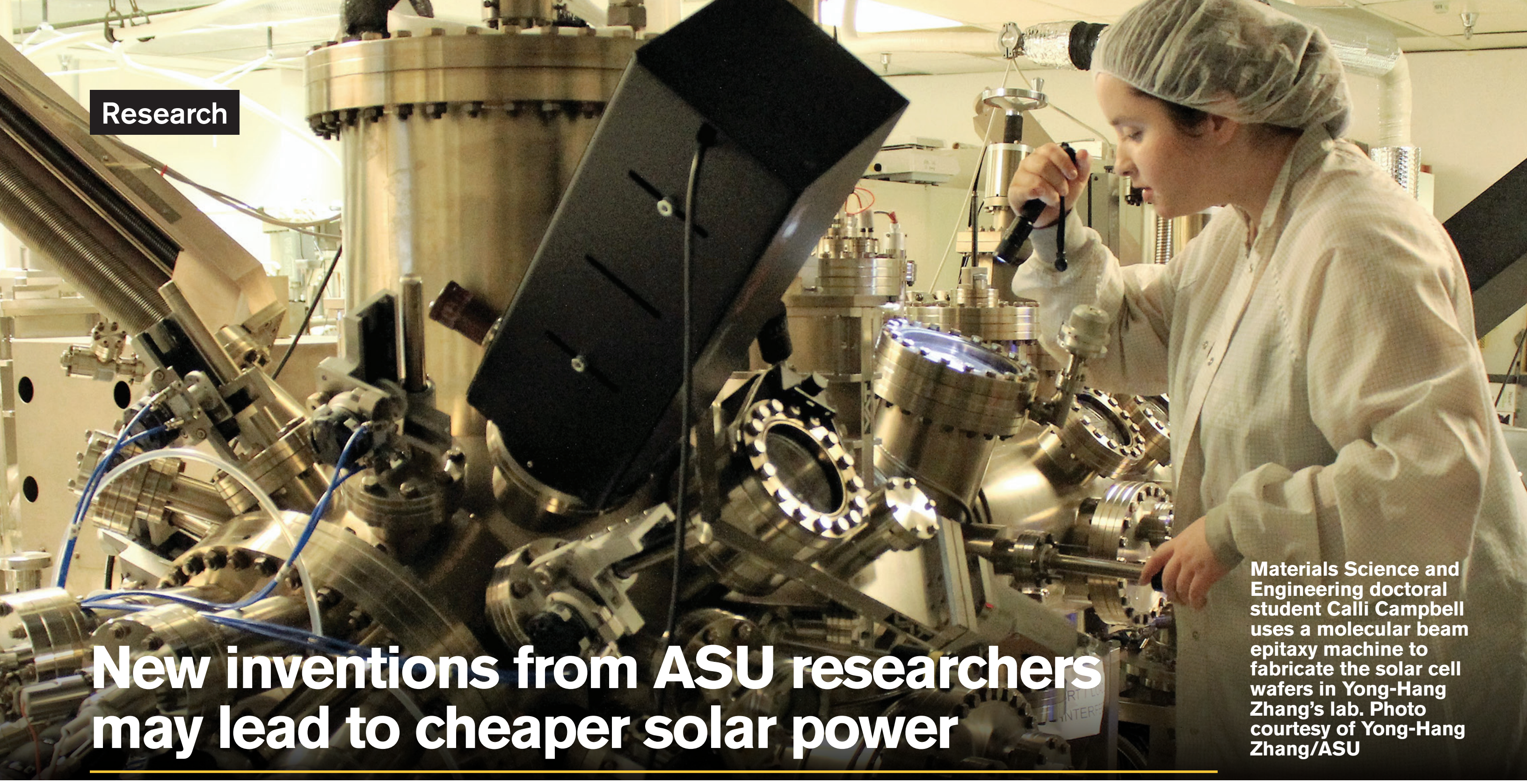


Illustration by Michael Hagelberg



New inventions from ASU researchers may lead to cheaper solar power

Materials Science and Engineering doctoral student Calli Campbell uses a molecular beam epitaxy machine to fabricate the solar cell wafers in Yong-Hang Zhang's lab. Photo courtesy of Yong-Hang Zhang/ASU

For decades, the preferred material for solar cells has been silicon, which provides the best return on investment in terms of energy production. Their counterparts, thin-film solar cells, while inexpensive and more robust, have remained a distant second because materials science challenges have limited their performance — until now.

A unique collaboration between researchers within the Fulton Schools has wedded two previously disparate solar technologies, resulting in significant improvements to cadmium telluride (CdTe) thin-film solar cells. Their impressive inventions offer a new approach to this problem in materials science and take another step toward lower-cost and widely accessible solar power.

In a paper published in the May 2016 issue of the journal Nature Energy, researchers led by electrical engineering Professor Yong-Hang Zhang and Assistant Professor Zachary Holman detail the results of their collaboration, which include not only breaking an efficiency record for monocrystalline CdTe cells by a large margin, but more importantly, also achieving the highest open-circuit voltage ever recorded in this type of cell.

Overcoming a long-standing obstacle

Open-circuit voltage is one of the very key factors determining how efficiently electricity can be generated from sunlight by a solar cell — voltage measures the potential for the solar cell to pump electricity around a circuit. High voltage is created when light is absorbed in a solar cell, exciting electrons by shaking them off their atoms. The electrons then build up on one side of the solar cell, like at the negative terminal of a battery.

Engineering a solar cell with high voltage is challenging because the excited electrons can be lost within microseconds or even nanoseconds of sunlight hitting a solar cell. Thus, a goal of solar cell research is to extract the electricity before it dissipates, which is generally accomplished by adding conductive contacts to the top and bottom of a solar cell, according to Zhang.

"However, the traditional contacts are made through introducing impurities in the solar cell absorbing layer, which can degrade the device performance dramatically," said Zhang.

To overcome this dilemma, Zhang, Holman and their research teams did not introduce a p-type impurity to the absorber layer but instead added a separate contact layer of low-cost amorphous silicon. In doing so, they've created a solar cell that has a substantially improved capacity with a voltage of 1.1 volt, an unimaginable feat even one year ago.

"This was accomplished with the creation of a solar cell using a double heterostructure combined with the novel contact layer design," said Zhang. "Essentially, we've created a solar cell that allows for the maximum number of electrons possible to build up before extracting them quickly and efficiently out the 'smart' contact."

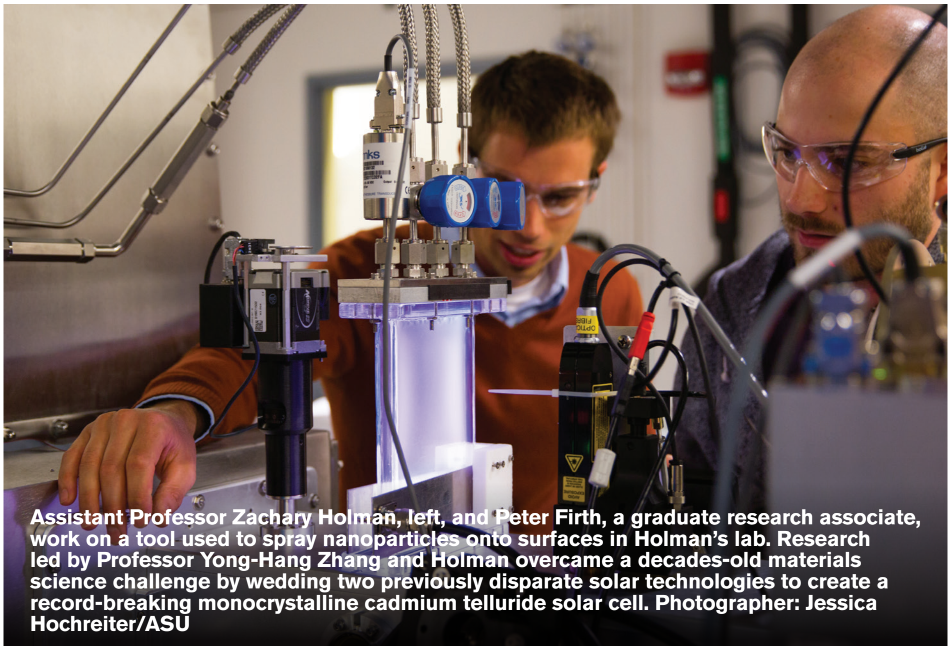
While attaining this level of voltage is significant, the cells have also reached 17 percent efficiency, breaking the record of only 15.2 percent for monocrystalline CdTe solar cells. While other types of solar cells, such as silicon, boast a best efficiency rating of around 25 percent, such a dramatic improvement in CdTe efficiency shows promise for the scaled use of the technology.

Zhang's next goal is to reach 20 or even 26 percent efficiency with CdTe cells in the next year or two.

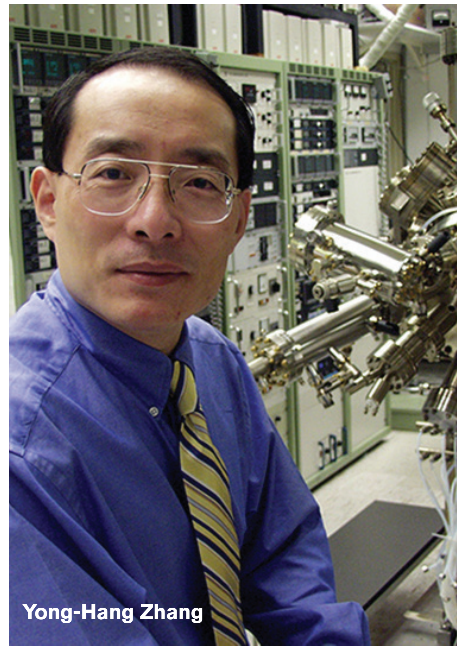
Impact on Industry

"The important thing is that this material system has been proven cost effective, but never efficient enough in terms of energy production to take over the solar market," said Zhang. "Many times with a paper such as this, the findings are either scientifically interesting or commercially applicable, but not both. However, these results are."

While silicon solar panels dominate the market, there are about 10 Gigawatts — enough to power 2.5 million homes — of CdTe solar panels in use worldwide today. In fact, the Tempe, Arizona-based First Solar is uniquely positioned to leverage the improved technology as the world's largest manufacturer of thin-film solar cells.



Assistant Professor Zachary Holman, left, and Peter Firth, a graduate research associate, work on a tool used to spray nanoparticles onto surfaces in Holman's lab. Research led by Professor Yong-Hang Zhang and Holman overcame a decades-old materials science challenge by wedding two previously disparate solar technologies to create a record-breaking monocrystalline cadmium telluride solar cell. Photographer: Jessica Hochreiter/ASU



Yong-Hang Zhang

"These latest results further confirm our long-standing conviction that CdTe is an ideal material choice for photovoltaic application," said Markus Gloeckler, Vice President of Advanced Research at First Solar. "Reaching an open-circuit voltage of 1.1 V is a milestone for the technology and provides confidence that thin-film CdTe has not reached its limits and further improvements beyond 22 percent are possible."

Holman added, "With ever-increasing production of CdTe modules, these innovations could result in more efficient solar panels worldwide if they successfully translate to commercial polycrystalline CdTe technology."

While the impact of the findings on the solar industry remains to be seen, these impressive results are a product of seamless cooperation between Zhang and Holman's respective research teams.

"It's a unique collaboration, and one that happened in the best way possible: through student initiative," said Holman. "One of Yong's students reached out to one of my postdocs, and things took off from there."

Though Zhang and his group initially conceived the underlying concept of these breakthrough solar cells, it took them more than two years to improve the materials needed to fabricate them. They also called upon Holman's expertise in silicon solar cells to marry two very different semiconductors to achieve these unique and efficient properties.

Zhang and Holman look to use their respective expertise to collaborate in the future as well.

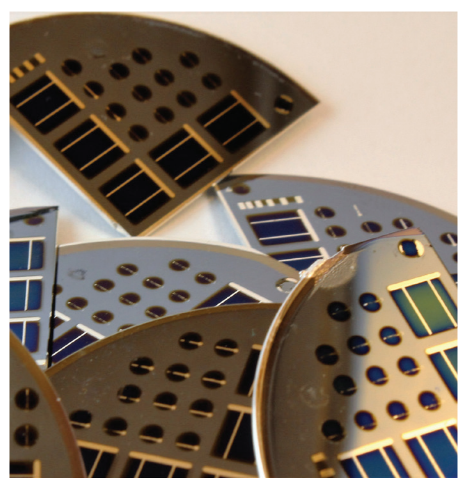
"We're exploring the possibility of developing a tandem solar cell, basically two complementary solar cells that would stack on top of one another, further boosting efficiency," said Holman.

While plans are underway for further collaboration, the professors' research teams are still hard at work. While this paper only covers findings within the last year, both Holman and Zhang's groups have demonstrated improved results within the past five months, which they presented at the Institute of Electrical and Electronics Engineers' Photovoltaic Specialists Conference in Portland, Oregon, in June 2016.

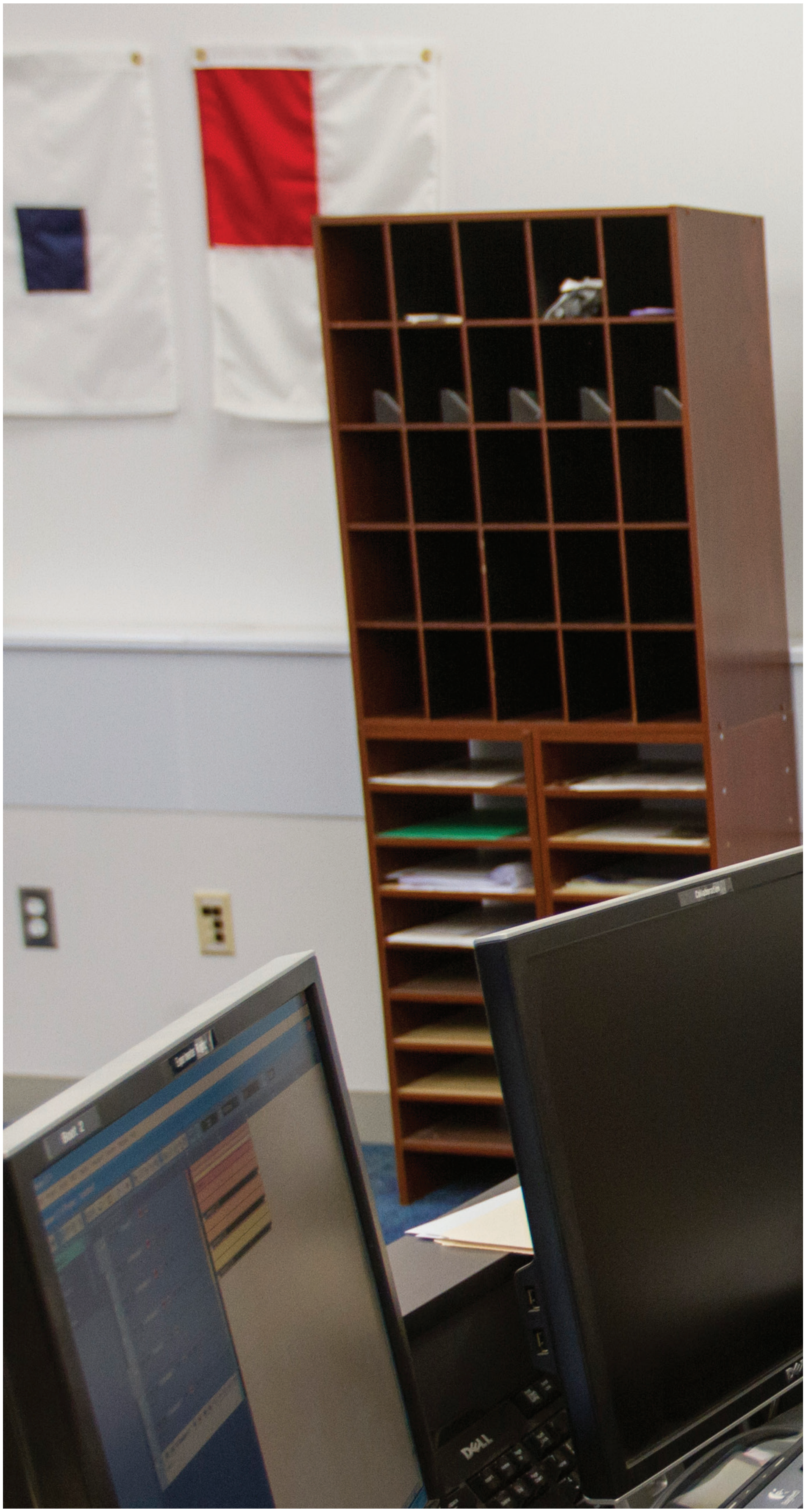
The research was mainly supported by funding from the U.S. Department of Energy's Bay Area Photovoltaic Consortium (BAPVC), a collaboration between universities, industry and government dedicated to improving photovoltaic technology, jointly led by Stanford University and University of California Berkeley.

Additional funding was supplied through NSF-DOE Quantum Energy and Sustainable Solar Technologies (QESST), one of four National Science Foundation-funded Engineering Research Centers led by the Fulton Schools at ASU.

Initial support for this research came from the Science Foundation Arizona in 2007, and subsequent funding from the National Science Foundation, the Army Research Office, the Air Force Research Laboratory and the Air Force Office of Scientific Research has paved the way to enable many of these new ideas developed over the past 10 years, according to Zhang.



The fruits of Professor Yong-Hang Zhang and Assistant Professor Zachary Holman's collaboration: record-breaking monocrystalline cadmium telluride solar cells, which shatter an efficiency record and boasts the highest voltage ever for its type of cell. Photographer: Cheng-Ying Tsai/ASU



Nancy Cooke: Advancing the science of teams

Team chemistry is key ingredient in formula for research success

In action-packed science fiction movies, victory over the indomitable foe is often the result of a lone hero or a single genius.

But in real life it never happens that way. Professor Nancy Cooke knows victory is more often a result of calculated, committed teamwork.

As a psychologist and chair of the Fulton Schools of Engineering human systems engineering program, Cooke's research focuses on individual and team cognition and its application to the development of cognitive and knowledge engineering methodologies, healthcare, homeland security systems, remotely piloted aircraft and emergency response systems.

Cooke says the increasing complexity of the technological solutions that scientists and engineers are chasing today is making it clear that progress demands not only the most talented researchers but also those with the best teamwork skills.

That realization prompted the National Science Foundation to ask the National Academies of Science, Engineering and Medicine to assemble a group of experts to seek ways to improve the effectiveness of research teams.

The 13-member Committee on the Science of Team Science, led by Cooke, completed their report in 2015, which emphasizes that successful science and engineering collaborations hinge not just on a high level of research expertise but also on organization, planning, management and communications skills — and on leadership that can instill a shared vision of the significance of the project goal.

Cooke, who also boasts the Arnold M. Small President's Distinguished Award from the Human Factors and Ergonomics Society, is currently excited about teaming up as a member of the Foresight Initiative, an ASU effort to look at how to anticipate and mitigate the national security risks associated with climate change.

Nancy Cooke, standing, with graduate student Jessica Twyford.

Ron Askin: a dedicated, driving force behind Fulton Schools rise and recognition

This year, Ron Askin's alma mater Lehigh University awarded him its 2016 Distinguished Alumni for Excellence in Academia.

In 2009, Askin became the inaugural director of the School of Computing, Informatics, and Decision Systems Engineering, one of the Ira A. Fulton Schools of Engineering, where he served until June 2016. His goal was to strengthen the school's core disciplines and increase the size and scope of its student body, faculty and research.

The school's excellence gained attention in 2014 when the Shanghai Jiao Tong University ranked the computer science program as 22nd in the U.S. and 33rd in the world for its research impact. The Industrial Engineering program was ranked in the top 20 by the U.S. News and World Report.

Next semester he'll step back into a faculty role, working closely with his students to solve problems in logistics and supply chain engineering.

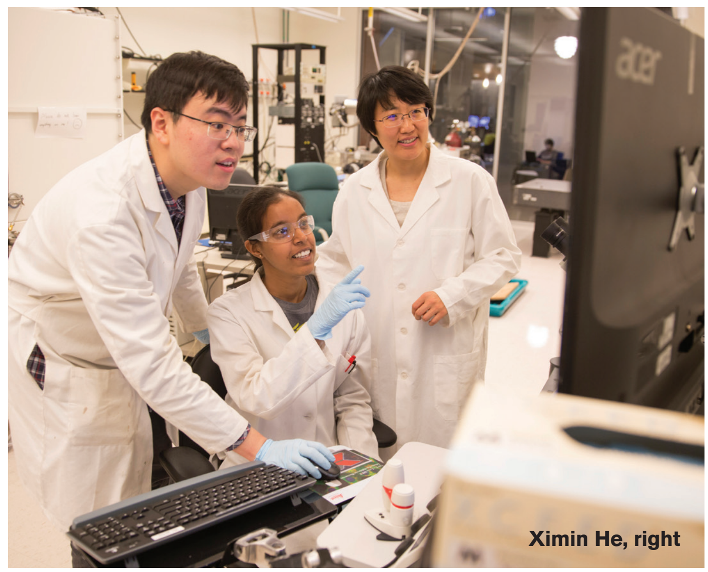

Ron Askin

Body's natural molecular mechanisms provide blueprint for better technology

Ximin He, an assistant professor of materials science and engineering, is pursuing technological advances that would mimic the way the body performs a specific feat: gathering up specific types of molecules, and then moving and distributing them to organs and other internal locations where they're needed.

Such an achievement could open paths to better water purification and treatment, as well as more effective removal of heavy metals, medical diagnoses, environmental protection, food processing and energy efficiency.

Her progress toward these goals has earned He a National Science Foundation CAREER Award to support her research. The award will provide about $500,000 over five years.

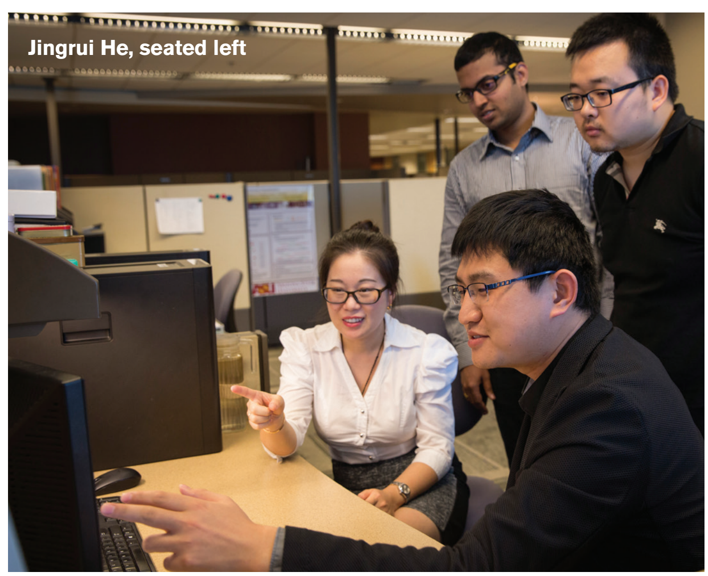

Ximin He, right

Bringing disparate data together with new computing theories and tools

We live in a world of Big Data, where we can capture a continuous stream of information from all kinds of systems. However, as the scope and sources of data expand, it becomes harder to model and analyze the data to make these systems better.

Assistant Professor Jingrui He is addressing this challenge by building upon her experience working at IBM Research.

She set out to answer these questions by creating new algorithms and theories that will advance the ability to analyze multiple types of heterogeneous data. Her efforts have earned her a National Science Foundation CAREER Award with more than $500,000 in funding to help her achieve her research goals.


Jingrui He, seated left

Sefaattin Tongay, center

Imperfections make 2D materials potential powerhouses for producing tech advances

Assistant Professor Sefaattin Tongay's focus is on two-dimensional (2D) materials — some of the thinnest of all materials, only 0.7 nanometers or a couple atoms thick — and the myriad functions they can perform when their crystalline atomic structures are less than perfect.

His overarching goal is to discover how to create the precise kinds of imperfections in 2D materials to maximize their potential in energy conversion and information technologies. The combination of the unusual properties of 2D materials can lead to a wide range of novel devices and other technology with defense, aerospace, medical, energy and industrial applications.

Tongay's work recently earned him National Science Foundation CAREER Award.

Barzin Mobasher, right

Materials research builds foundation for a better world

Professor Barzin Mobasher wants to develop the next generation of the two-by-four that's not wood, but acts like wood — a material more suitable for a wider range of infrastructure projects.

For his accomplishments the American Concrete Institute gave him its Delmar L. Bloem Distinguished Service Award at the ACI Spring 2016 Concrete Convention and Exposition in Milwaukee, Wisconsin. The award recognizes his work as committee chair in publishing three international reports that detail new design procedures he has developed through his materials research at ASU.

The award is a great honor, but, above all, Mobasher hopes this will put the spotlight on sustainability and social justice issues about which he has been trying to raise awareness: including how substandard housing affects almost two billion people worldwide.

Narayanan Neithalath, right

Neithalath cementing his status as pioneering civil engineering researcher

Professor Narayanan Neithalath's strides in research to improve the design and development of sustainable infrastructure and construction materials earned him the American Society of Civil Engineer's Walter L. Huber Civil Engineering Research Prize.

Neithalath is making particular progress with new materials and methods for producing more durable cement and concrete. His efforts also span the environmental impacts of their production and use.

He was also named a 2016 Faculty Exemplar by the Ira A. Fulton Schools of Engineering. Fulton Exemplar Faculty possess a combination of high research productivity, instructional load, student evaluations and doctoral student mentoring.

School of Biological and Health Systems Engineering

Sydney Schaefer
Assistant Professor
Ph.D., Pennsylvania State

Expertise: Motor control and learning, anatomy and physiology, experimental design and ethics, biomechanics, neuroscience

Jamie Tyler
Associate Professor
Ph.D., University of Alabama at Birmingham

Expertise: Neural engineering

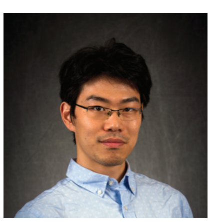
School of Computing, Informatics, and Decision Systems Engineering

Adolfo Escobedo
Assistant Professor
Ph.D., Texas A&M University

Expertise: Theory and application of optimization, mathematical programming error reduction/elimination

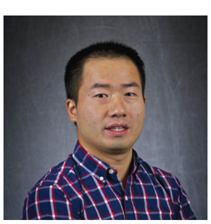
Giulia Pedrielli
Assistant Professor
Ph.D., Politecnico di Milano, Italy

Expertise: Simulation methodology, stochastics and learning/statistics related to simulation improvement both for performance evaluation, simulation-based optimization of complex systems



Yezhou Yang
Assistant Professor
Ph.D., University of Maryland, College Park

Expertise: Computer vision, autonomous intelligent robots, artificial intelligence



Yu (Tony) Zhang
Assistant Professor
Ph.D., University of Tennessee, Knoxville

Expertise: Multi-agent systems, human-aware planning, multi-agent planning, automated planning and scheduling, distributed robot systems, human-robot interaction

Javier Gonzalez-Sanchez
Lecturer
Ph.D., Arizona State University

Expertise: Software engineering, human-computer interaction

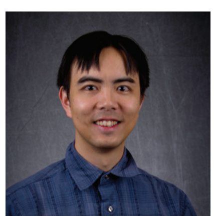
Alexandra Mehlhase
Lecturer
Ph.D., Technische Universität Berlin

Expertise: Modeling and simulation of variable-structure models, software engineering

School of Electrical, Computer and Energy Engineering

Angelia Nedic
Professor
Ph.D., Massachusetts Institute of Technology

Expertise: Distributed and large-scale optimization, convex and nonsmooth optimization, game theory and variational inequalities, duality and convexity theory, stochastic approximations, dynamic systems, applications in communication networks, signal processing, machine learning, and sensor networks



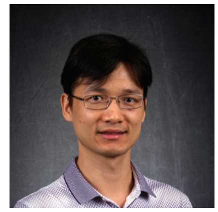
Robert LiKamWa
Assistant Professor
Ph.D., Rice University

Expertise: Operating systems, computer architecture, machine learning

Joint appointment with the ASU Herberger Institute for Design and the Arts' School of Arts, Media and Engineering

Anamitra Pal
Assistant Professor
Ph.D., Virginia Tech

Expertise: Utility power systems, power transmission and smart grids, large scale system monitoring, protection and control



Chao Wang
Assistant Professor
Ph.D., Princeton University

Expertise: Novel nanostructure fabrication techniques, synthesis and fabrication of 1D and 2D nanostructures and nanomaterials, nano-sensors, micro-/nano-fluidics

Yang Weng
Assistant Professor
Ph.D., Carnegie Mellon University

Expertise: Power systems, machine learning, optimization

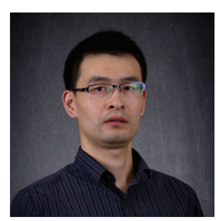
Shamala Chickamenahalli
Professor of Practice
Ph.D., University of Kentucky

Expertise: Design, analysis, simulation, modeling, control of high frequency package and integrated voltage regulator and inductor topologies for microprocessor power delivery

Robert Rucker
Lecturer
Ph.D., Arizona State University

Expertise: Software engineering

School for Engineering of Matter, Transport and Energy



Qiong (Eric) Nian
Assistant Professor
Ph.D., Purdue University

Expertise: Laser-based advanced manufacturing and materials processing, large scale thin film manufacturing, renewable energy device fabrication and manufacturing, additive manufacturing and 3D printing

Sze Zheng Yong
Assistant Professor
Ph.D., Massachusetts Institute of Technology

Expertise: Robotic and autonomous systems, intention-aware systems, fault diagnosis and resiliency in control and estimation, automatic steering and motion planning for self-driving cars, event-triggered and quantized systems, hidden mode hybrid systems, optimal filtering, adaptive and optimal control

Luis Bocanegra
Professor of Practice
Ph.D., West Virginia University

Expertise: Thermodynamics, statistical process control, lean manufacturing, root-cause analysis, plastics extrusion, thermal modeling

Srinavas Kosaraju
Lecturer
Ph.D., Florida State University

Expertise: Engineering design, optimization, microchannels, thermal management, renewable energy

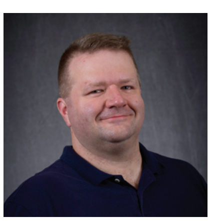
Jay Patel
Lecturer
Ph.D., Arizona State University

Expertise: Finite element analysis, experimental mechanics

School of Sustainable Engineering and the Built Environment

Ram Pendyala
Professor
Ph.D., University of California at Davis

Expertise: Sustainable land use transport systems, transportation systems planning, transportation systems modeling and simulation



Christian Hoover
Assistant Professor
Ph.D., Northwestern University

Expertise: Fracture mechanics, materials testing, porous materials

Guiseppe Mascaro
Assistant Professor
Ph.D., University of Cagliari

Expertise: Stochastic hydrology, watershed modeling, soil moisture and precipitation downscaling, hydroinformatics

Treavor Boyer
Associate Professor
Ph.D., University of North Carolina at Chapel Hill

Expertise: Wastewater treatment

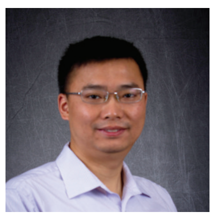
Leon Van Passen
Associate Professor
Ph.D., Delft University of Technology

Expertise: Soil behavior and mechanics, geochemistry, bio-based geotechnical engineering

The Polytechnic School

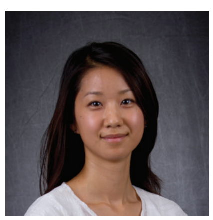
Bruno Azeredo
Assistant Professor
Ph.D., University of Illinois at Urbana-Champaign

Expertise: Scalable nanomanufacturing, micromachining, thin-film mechanics, electrochemical methods in manufacturing research



Yan Chen
Assistant Professor
Ph.D., The Ohio State University

Expertise: Automotive dynamics and control, hybrid powertrain vehicular systems, alternative and clean energy systems, vehicle safety systems



Erin Chiou
Assistant Professor
Ph.D., University of Wisconsin-Madison

Expertise: Human-automation systems

Laura Hosman*
Assistant Professor
Ph.D., University of Southern California

Expertise: International development, quality of life, information and communications technology, public policy, natural resources/environment, renewable energy/solar energy, public-private partnerships, technology in education, telecommunications, international relations, international political economy, economics, comparative politics, methodology/mixed methods

Darshan Karwat*
Assistant Professor
Ph.D., University of Michigan

Expertise: Renewable energy, climate change, social justice, environmental policy

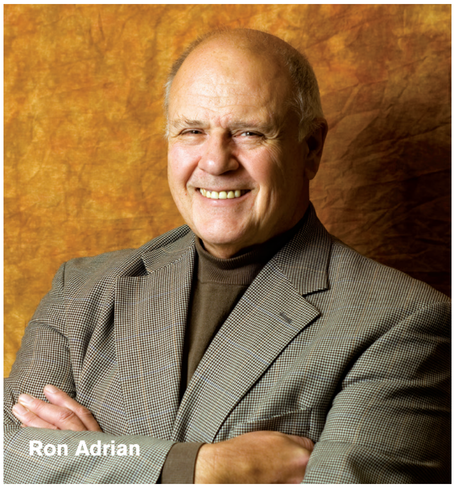
Thaddeus Miller*
Assistant Professor
Ph.D., Arizona State University

Expertise: Science and technology studies, socio-technical systems, urban sustainability, science and technology policy, infrastructure studies, sustainability science, transdisciplinary research and education

H. John DeLugt
Lecturer
B.A., Arizona State University

Expertise: Operational monitoring, active learning, instruction, preparing training reports

** Joint appointment with ASU's School for the Future of Innovation in Society.*



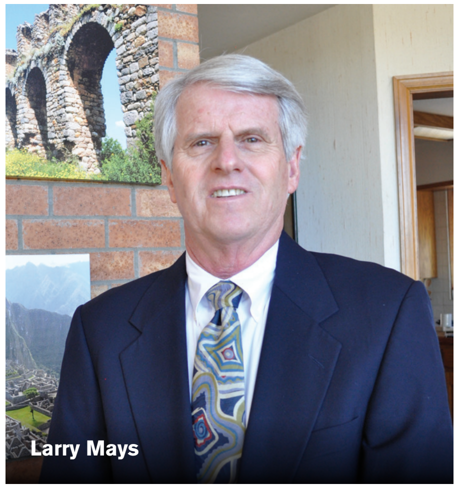
Far-reaching engineering contributions earn Adrian honorary doctorate

For accomplishments that have made him arguably the most important living experimental fluid mechanician of the past 50 years, engineer Ron Adrian will be awarded an honorary doctorate from the University of Illinois at Urbana-Champaign.

Adrian spent more than 30 years teaching and conducting research at UIUC before joining ASU in 2005 and becoming the Ira A. Fulton Professor of Mechanical and Aerospace Engineering.

For decades he has been among the leading experts in fluid dynamics. His work has included development of devices and techniques that have enabled advances in research, earned patents and fostered new industry ventures.

He was previously given an honorary degree from Portugal's Technical University of Lisbon.



Mays' stature as foremost water resources engineer boosted by latest tributes to career achievements

Professor Larry Mays' accomplishments in water resources engineering over the past four decades continue to bring him prestigious honors.

He was recently awarded the American Society of Civil Engineers Ven Te Chow Award for "exceptional achievement and significant contributions in research, education and practice" in the field of hydrologic engineering.

On April 21, he was inducted into the Academy of Civil Engineers at the Missouri University of Science and Technology where he earned undergraduate and master's degrees in civil engineering. Mays also earned the status of Fellow of the International Water Association.

Professor earns 2016 NAMS Young Membrane Scientist Award

Chemical engineering Assistant Professor Matthew Green was presented with the North American Membrane Society (NAMS) Young Membrane Scientist Award at the 2016 NAMS conference.

The NAMS Young Membrane Scientist Award is given annually to up to three post-docs and faculty at the beginning of their professional careers in membrane science and technology.

At the conference Green presented his work on the design of ionomer block polymers as battery electrolytes and electromechanical transducers, which has applications in energy storage and harvesting devices.

Innovative ideas for enhancing rehabilitation earn foundation's support

Science Foundation Arizona gave one of two 2016 Bisgrove Scholar awards to Wenlong Zhang, an assistant professor of engineering in the Polytechnic School.

Zhang's research focuses on the design, modeling and control of cyber-physical systems that can be applied in healthcare, manufacturing and robotics.

The Bisgrove award will provide $200,000 to expand his efforts to develop mobile and intelligent gait-rehabilitation systems.

The systems will enable people with standing and walking difficulties to be fitted with wireless body sensor networks and wearable robotic rehabilitation technology to aid them in doing exercises to better understand and improve their gait (walking motion).

Micah Lande (right) with student makers

Making the most of a Tooker Professorship

Micah Lande identifies first and foremost as a maker.

And he thinks you're one, too.

"For me, everyone is a maker," says Lande, an assistant professor of engineering and manufacturing engineering. "It's an inherently human thing to want to build and create."

Lande thinks this innate maker spirit can be harnessed to better engage and educate engineering students. He sees it as part of what already puts the Fulton Schools on the leading edge of engineering education. Lande's passion for making — a growing movement that encourages learning-by-doing through tinkering with technology and tools — recently landed him a coveted Tooker Professorship.

Selected annually through a competitive proposal process, Tooker Professors are appointed for one- to two-year terms during which they implement innovative projects to increase engineering student retention and persistence, create more rewarding learning experiences and greater student diversity as well as provide experiences that give engineering students a competitive edge in the job market.

The Tooker Professorship was established in 2011 with an endowment from Diane and Gary Tooker. Diane is a former elementary school teacher, and Gary is one of our engineering alumni and the former CEO of Motorola; both are passionate about creating exciting learning environments that attract students to and retain them in STEM fields.

Lande's winning proposal envisions the Fulton Innovation Corps, a set of opportunities for engineering students to explore, develop and deploy solutions to problems they care about outside of their prescribed programs of study. He's excited at the prospect of using his Tooker Professorship to further these goals.

"It's a way to evangelize my interest and passion for empathy-led design thinking, prototyping and making, as well as entrepreneurship, and share that with Fulton engineering students," says Lande. "It's also a means to get potential engineering students excited about what I see as the really useful and impactful educational pathway to becoming an engineer — to make a difference."

At the core of his work is the idea that technical and non-technical people alike can imagine, build and make their future.

"For me, the fun part about being a professor is setting the stage for a learning experience where I can be surprised and delighted by what students come up with," he says. It's exciting to see the ways our students go out and make the world better. The notion of the New American University — an inclusive educational entity — seems to me very much in line with the maker community and its methodology."

In the pursuit of cross-pollinating making and engineering, Lande's projects largely center on programs that aim to engage both Fulton Schools students and potential engineering students. Lande will grow his summer outreach program "The Art of Invention" that emphasizes design thinking and creative problem solving as well as making and tinkering. Leveraging his existing partnership with the Maker Education Initiative, Lande hopes to give incoming engineering freshmen a jump-start on innovative thinking and problem solving that can be applied to their coursework as well as provide an opportunity for Fulton engineering students to mentor incoming students.

"Students are able to get their hands dirty, making stuff right from the start and experiencing what engineering is and what it can do in particular contexts. They will invent and innovate, and get excited about engineering through making," says Lande.

Additional activities during the academic year will help students use design thinking and making to solve problems in service of local communities.

David Benson, standing, center, with members of the HEEAP Vocational Cohort in one of the Fulton Schools' eSpace classrooms on the Tempe campus

ASU's Southeast Asia engineering outreach accelerates in Vietnam, expands to Indonesia

Six years after the Higher Engineering Education Alliance Program (HEEAP) was launched in Vietnam, President Barack Obama highlighted ASU's efforts during a May 22 news conference from Hanoi. The following day, Secretary of State John Kerry also noted that such academic partnerships are key in terms of a "transformational, long-term impact of a relationship" during a news conference in Ho Chi Minh City.

The program, which began as a partnership between the Fulton Schools of Engineering, the United States Agency for International Development (USAID) and Intel, was created to introduce professors from eight Vietnamese universities to engineering teaching practices and curriculum focused on accreditation. The international kudos coincide with an expansion of the program both within Vietnam and into Indonesia.

To date, HEEAP has provided engineering education support and training to nearly 5,000 Vietnamese participants, 27 percent of whom are women, from 20 universities and technical programs, and has invested more than $25 million in higher education innovation. Ho Chi Minh City University of Technology (HCMUT) has achieved ABET accreditation and several Vietnamese universities have acquired Association of Asian Nations (ASEAN) University Network (AUN) Quality Assurance accreditation.

"ASU's presence in Vietnam has contributed significantly to strengthening its position with both ASEAN and the Trans Pacific Partnership," explained Jeffrey Goss, Global Outreach and Extended Education (GOEE) and HEEAP executive director. "The next phase of the program will deepen that path and extend it into Indonesia."

Below: President Barack Obama addresses the audience during the Youth in Southeast Asia Leadership Institute (YSEALI) Town Hall in Ho Chi Minh City. Photographer: Jeffrey Goss/ASU

ASU in Southeast Asia

"At the end of the news conference, President Obama walked the conference hall bowl and I had the chance to shake his hand and introduce myself from ASU," said Goss, who noted that the President told him "Arizona State is doing great work in Vietnam and please keep doing it … it is important to the U.S.-Vietnam Partnership."

President Obama arrived in Ho Chi Minh City late in the day on May 24 and spent time at the Dreamplex — an incubator and co-working space in the heart of Saigon. "We were successful getting two of our former HEEAP faculty approved to showcase their research and ventures," explained Goss. "They had one-on-one discussions with the President and Secretary Kerry during this event. We had them proudly in ASU polo shirts."

According to Goss, the President asked one of the faculty about his experience at ASU and then said, "Wow, I keep hearing about Arizona State all over the place."

ASU was again featured at the Young Southeast Asian Leaders Initiative (YSEALI) Town Hall. "This was an event where I had the opportunity to sit in the front row with United States Ambassador to Vietnam Ted Osius, Vietnam Ambassador Pham Quang Vinh, Secretary of State John Kerry, and Vice President and General Manager of Intel Products-Vietnam Sherry Boger, among others," said Goss. "There were around 800 YSEALI alumni in the audience, six of whom had recently completed the YSEALI Program at ASU. It was a very gratifying experience."

BUILD-IT expands program in Vietnam

The Building University-Industry Learning and Development through Innovation and Technology (BUILD-IT) program, the third of the HEEAP initiatives, was launched in May following a partners' kick-off meeting which included industry, government and academic partners, with acknowledgment from President Obama. On June 2, Ho Chi Minh City University of Science (HCMUS), one of the first to sign a memorandum of understanding, hosted a commemorating event for USAID and BUILD-IT implementing partner, ASU.

BUILD-IT links science, technology, engineering and math (STEM) instruction to the needs and capabilities of industry partners, with the goal of creating graduates who can lead inclusive, technology-based careers. More than 20 industry partners currently support the program.

HCMUS is one of a dozen universities slated to partner with BUILD-IT. Additional academic agreements and new industry partnerships are ongoing, with initial alliance program activities having begun summer of 2016. A key objective of HCMUS is accreditation by the AUN in the areas of biotechnology, chemistry, mathematics and computer science.

"When HEEAP was launched, it was because Intel envisioned a transformation of engineering education in Vietnam," said Goss. "It sought to do so in a way that would advance education leadership, faculty training, teaching methodology, curriculum and, perhaps most importantly, standards-based outcomes that would prepare Vietnamese engineers to compete in a global economy. The BUILD-IT Program represents that ability to compete."

According to Kathy Wigal, Ed.D., associate director of Curricular Innovation, GOEE, who will administer the BUILD-IT Program, HEEAP-trained Vietnamese faculty will serve as the link in developing university STEM education in alliance with industry partners seeking graduates prepared for technical careers.

LEEAP in Indonesia

A two-day symposium in Jakarta on the Leadership in Engineering Accreditation Program (LEEAP) in late May marked a one-year USAID Higher Education Leadership and Management (HELM) special initiative designed to support university-level engineering programs to become globally competitive and achieve AUN and ABET accreditation.

During the symposium, five academic program teams showcased their progress for an audience representing 40 Indonesian universities, industry representatives and Indonesian and United States government officials.

The symposium was followed by the US-ASEAN Business Council Forum on Human Capital Development, co-organized and co-sponsored by ASU, for a gathering that brought together representatives from industry, academia and government.

Led by Martin Gil, President-Director of Coca-Cola Indonesia, the forum was structured around panel discussions. "The purpose of the forum today is to bring together key representatives from the private sector, government and academia to discuss ways of improving the domestic ecosystem for human capital and workforce development," Gil told the assembly.

Kathy Wigal, who served as a panelist during the discussions, invited attendees to participate in a follow-up dialogue to explore public-private human capital development alliances in Indonesia. "We have learned a great deal through our year-long special initiative and collaboration with the HELM project, and look forward to developing deep and diverse partnerships that share the goal of tightly linking STEM instruction in higher education institutions to the needs and capabilities of industry partners," Wigal said. "Producing graduates who can lead inclusive, technology-based growth begins with developing relationships and coming together. Today we have taken the first step."

Representatives from the U.S. Embassy, Indonesian Ministries and boards, and U.S. corporations including Microsoft, Amazon, Google, Honeywell and others, expressed interest in partnership opportunities and the creation of an alliance model.

The ASU team's activities in Indonesia culminated in an Assessment and Evaluation Workshop for Andales University in Padang. Wigal and Scott Danielson, an associate professor in the Polytechnic School, led their fifth workshop in the series. Focused on assessment and evaluation of student learning, the participants included 25 faculty members from Indonesian civil, electrical, environmental and mechanical engineering programs.

Developing international faculty relationships

According to Wigal, incentives and motivations for change and improvement will become more intense as the ASEAN economic borders are lowered and institutional autonomy increases. In 2014, Vietnam's National Assembly passed a law to expand higher education investment and increase autonomy at the system and institutional levels, giving institutions and faculty greater freedom to make curriculum decisions and set institutional operating policy. "This will allow the institutional leadership to respond with policies, curriculum and competencies to reshape their institutions to meet market needs, promote innovation and foster inclusion," Wigal explained.

And word of ASU program successes in Indonesia is spreading. "That's how we got involved in Indonesia — if Vietnam can do it, then why not Indonesia?" she said.

Evident to all ASU staff working in Southeast Asia is how strong the drive is within the faculty and leadership to improve STEM education in their countries. "It's rewarding to see those we have trained through the HEEAP faculty development cohorts go on to become program leaders and deans. They see that they can make a real change in education, Wigal said. "That's a real motivator for them, and for our team."

Wigal says she now has friends and colleagues in both Vietnam and Indonesia, noting that she feels very connected to faculty in HEEAP's partner universities, and beyond. "You would be surprised how many people will notice my ASU shirt — they've heard of ASU and ask me about our work no matter where I travel, whether its Southeast Asia for work or on my recent vacation in Ireland — everywhere they know ASU — we are world class!"

One of the robotic autonomous cars built by students in Associate Professor Aviral Shrivastava's Embedded Microprocessor Systems class.

Robotic autonomous cars teach whole system design

Computing doesn't happen in isolation. Today's computing systems, like those in cars and appliances, are increasingly intertwined between software, electronics and mechanical components. As computing becomes more integrated in everyday objects, engineering students need a hands-on, comprehensive approach to understand how these parts interact.

Computer science and engineering Associate Professor Aviral Shrivastava identified autonomously driving vehicles — robot cars — as a way to teach the complexity of today's computing systems to his students.

Keeping up with the computing times

Last fall, Shrivastava noticed that the required embedded systems course he would teach this spring, Embedded Microprocessor Systems (CSE 325), didn't prepare students to work with modern embedded systems — computing systems incorporated into electronic devices beyond personal computers. The purely computing systems of old no longer cut it. More complex cyber-physical systems are the new normal.

"Cyber-physical systems are systems that have both a computing aspect and a physical or real-world aspect," Shrivastava says. "The key difference from embedded systems comes from the fact that when designing embedded systems you are concerned only about the computing aspect of the problem, but in cyber-physical systems you need to understand the physical aspects to be able to design the system correctly."

Robotic cars teach system-level design

Autonomous cars are one high-profile example of a cyber-physical system that includes many of the embedded system concepts computer systems engineering students need to learn and represents an exciting and growing industry. Scale that down to a semester-length project, and students in Shrivastava's class get hands-on experience building a complex system through a robotic toy car they learn to build from scratch.

Computer engineering graduate student Edward Andert, who is a graduate teaching assistant for the Embedded Microprocessor Systems class, built a small robotic autonomous car for his undergraduate capstone project in 2013. That became the basis for the project the spring semester's 50 computer systems engineering students are building in class.

It's an involved assignment that has kept the bar high in a traditionally difficult computer systems engineering class. Students get the car chassis, batteries, wires, Arduino Mega microcontroller board, drive and steering motors, and sensors — inertial measurement unit (IMU), global positioning system (GPS) and Light Detection and Ranging (LIDAR) unit — learn how the components work and interact with each other, and put them together and program them in stages to add increasingly complex capabilities.

Andert says the updated Embedded Microprocessor Systems course focuses on the types of processors, protocols, sensors and other system parts used in smartphones, autonomous vehicles and other applications students are likely to see in their future careers.

Shrivastava designed the new version of the course to holistically teach three critical parts to design a cyber-physical system: parts of the system; processing and communication; and feedback control.

First, students learn how batteries, sensors and motors work within a system. Next, students learn about processors, protocols and programming similar to the original course that solely focused on computing. And last, students learn the systematic and continuous approach to getting a system to behave how they want.

Putting design skills to the test

On April 1, students had their demonstration of the fifth of seven projects in the course in which they used feedback control to drive the car to make a figure 8 with circles of two different diameters. Students had to continuously read the IMU sensor to figure out if the car was deviating from its course, and continuously correct it, so that it stays on the correct path. It should work correctly, even if the car is momentarily taken off course. To test this, the teaching assistant Mohammadreza Mehrabian picked up the car, and when he kept it in the air, it should try to right its course by correctly turning the wheels.

Most of the students successfully completed the project and they learned firsthand a valuable lesson in feedback loops.

"Once they started trying, they quickly realized that it is difficult to make the car drive in figure 8 without a feedback loop," Shrivastava says. "They applied feedback control and tuned it's parameters to be able to control the car. They saw how effective and useful feedback control is to make the system perform the way they want to."

Aviral Shrivastava

Jeremi London, second from left, with other members of the RED project

Jeremi London bridges a path towards better engineering education

An area that has become a heavy interest for London, an assistant engineering professor in the Fulton Schools, is impact and how it is defined and measured when it comes to research. London defines impact as "a time-sensitive interpretation of the extent to which a set of activities lead to change in and beyond the context in which the change originated."

"What does it mean for a federally funded project to have impact?" London asks. "You have tax dollars that are supporting research and the common taxpayer may or may not understand the research that is being done, but their resources are going towards supporting it. How can we begin to get better at communicating the impact of our work so that various stakeholders can appreciate the work that we do?"

There isn't a lot of scholarship on research impact currently, even though "impact" is a word that gets thrown around a lot. Impact isn't studied much in scholarly circles, but London posits that there are three major reasons why it's hard to study impact. These insights earned her the Best Paper Award at the 2015 Australasian Association of Engineering Education conference.

"The biggest problem is called the attribution problem, which is the struggle with connecting impacts of research with a particular project or researcher," she says. "Part of the reason it is so difficult is because impact diffuses through time and space. You complete research and it influences one person and what they go on to do, but there's no way to attribute the original research as being impactful."

"The second problem is the difficulties in assessment and evaluation," she continues. "What data is most meaningful and how do you collect data and who should be doing the assessment? When should the assessment take place and how might the timing of the assessment influence whether what you observe is a short-term or long-term impact? Depending on when an assessment is done, the impact will be varied as research evolves over time. In the education context, how do you account for impacts that cannot be codified, like the development of students' tacit knowledge and growth in expertise?"

"The last major issue is interpretation. You can have two stakeholders who have different viewpoints observe the same research on a particular topic and come to totally different conclusions about its impact — largely because they came from different points of view. Additionally, we automatically assume impact is positive and large, but negative and modest impacts exist as well," she explains.

Her dissertation was focused on how NSF-funded researchers on STEM education projects currently talk about the impact of their work. Her work led her to look at other disciplines to see how they measure impact. Now, she wants to know how engineers can build off what they do and discovered that there is crossover. Her current work is focused on developing a framework to characterize the impact of engineering education research. The hope is that having a framework will help facilitate consistent language around the topic, and assist researchers in communicating the impact of their work more effectively. She is also a member of the Revolutionizing Engineering Departments (RED) project, and conducting research that begins to address the attribution problem in the context of engineering education.


Edd Gibson


Kristen Parrish

Construction programs lauded for enhancing educational efforts

ASU's innovations in construction engineering and management education are being recognized with two of the major annual awards for professional development bestowed by the Construction Industry Institute (CII).

The CII Curriculum Partner Award acknowledges the academic progressiveness of the construction management program in the Del E. Webb School of Construction and the construction engineering program in the School of Sustainable Engineering and the Built Environment. The award recognizes education programs that are incorporating published CII research topics into their curriculum.

A CII Distinguished Professor Award for exemplary demonstration of commitment to teaching spotlights the work of Assistant Professor Kristen Parrish. The award recognizes the most outstanding university faculty members who are incorporating published CII research findings into the courses they teach.

The Construction Industry Institute, based at The University of Texas at Austin, is a consortium of more than 130 leading owners, engineering contractors and suppliers from both the public and private arenas. For more than 30 years, more than 50 universities have worked with CII on capital project research.

The mission of CII is to inspire owners, contractors/suppliers and academia to collaborate through research to produce best practices and implementation resources, creating innovative solutions that improve safety and capital efficiency.

ASU's construction management and engineering programs are using CII research findings extensively to enhance existing courses, design new courses and guide research pursuits, says Professor G. Edward "Edd" Gibson Jr., director of the School for Sustainable Engineering and the Built Environment.

Among these notable efforts:

Assistant Professor David Grau launched and leads a CII Best Practices course at ASU.

Assistant Professor Mounir El Asmar has developed new Sustainable Construction and Alternative Project Delivery courses that incorporate CII research findings.

Parrish and Associate Professor Kenneth Sullivan are launching a program to instruct faculty on new best practices for engaging students in construction management courses, focusing on the use of CII materials to facilitate hands-on, real-world, problem-based learning.

Associate Professor Avi Wiezel has developed a leadership course in which he employs tools and methods based on CII research findings into classroom learning activities.

Professor Samuel Ariaratnam incorporates many resources, including CII research, to demonstrate the workforce challenges affecting the construction industry in his Construction Project Management course. He has also launched a construction engineering program that enables students to pursue a professional engineer license in construction.

Gibson mentors construction program faculty members on incorporating results of CII research into their teaching, and he has helped to increase research at ASU that aligns with the CII's primary research interests.

Gibson accepted the Curriculum Partnership Award on behalf of ASU at the CII Annual Conference in National Harbor, Maryland, in August 2016.

Parrish's accomplishments as an educator include twice winning the top teaching award given by the Fulton Schools and attracting more than $400,000 to support her research to improve engineering education.

Parrish "is extremely passionate about her teaching and she strives to ensure every one of her students is learning effectively," Gibson says.

Prior to joining ASU in August 2012, Parrish was a senior scientific engineering associate at the Lawrence Berkeley National Laboratory, where she worked in the commercial buildings group. She developed energy-efficiency programs and did research to explore technical and non-technical barriers to promoting more energy efficiency in the building industries.

Parrish has a bachelor's degree and master's degree in civil engineering from the University of Michigan and earned a doctoral degree in civil engineering systems from the University of California, Berkeley.

Her work now focuses on improving the efficiency of building design, construction and operations processes. She is particularly interested in novel design processes that financially and technically facilitate on-time and on-budget construction, as well as energy-efficient operations.

Should engineers take more risks in the classroom?

If you are an engineering doctoral student with excess funding from a graduate fellowship, do you put it toward upgrading your car or training to become a skydiver?

Associate Professor Nadia Kellam chose skydiving, and her engineering career and skydiving escapades have been intertwined ever since. During her mechanical engineering doctoral studies, Kellam became a certified skydiving instructor. As an engineering faculty member at the University of Georgia she also entered professional skydiving competitions.

Her skydiving and engineering careers continued to take off. Between 2012-2014 she not only earned tenure, but also second and third place finishes in the U.S. Parachute Association's National Skydiving Championships. Now at ASU, Kellam not only experiences risk firsthand as she falls from the sky, performs as a flying trapeze artist and cruises on her motorcycle, but she also researches the role of risk-taking in the classroom.

Kellam is among a group of engineering education researchers from the Polytechnic School, inciting a revolution in engineering education. With funding from the National Science Foundation's Revolutionizing Engineering Departments (RED) program, the group is, in part, examining how sustaining a mindset of risk-taking in the classroom can produce engineering graduates ready and excited to tackle society's most pressing challenges.

Through her studies in narrative inquiry, Kellam interviews students and analyzes the motivations and factors that develop their identity as engineers. Frequently, students find their way to engineering because they're good at math and science or want to make money and have career stability, she finds.

"Although these are valid reasons, they reflect a limitation in engineering education to attract a critical mass of students interested and committed to addressing the grand challenges of today," says Kellam.

"Diversifying the engineering workforce with the inclusion of different perspectives, life stories and experiences is vital to meeting society's engineering needs," she adds.

Creating an educational culture that values risk-taking will enable students to go beyond textbook problems and extrinsic rewards. Students can become systems thinkers who understand and contribute to big, complex problems, while also exhibiting technical prowess.

This approach can change ASU's ability to attract students who may not have been considering engineering, but have a great deal to offer to the field. But producing these type of students requires risk-taking to start at an institutional and faculty level.

"Risk-taking in the classroom prepares students to ask critical questions and produces graduates who pursue careers that promise to make an impact after graduation," says Kellam.

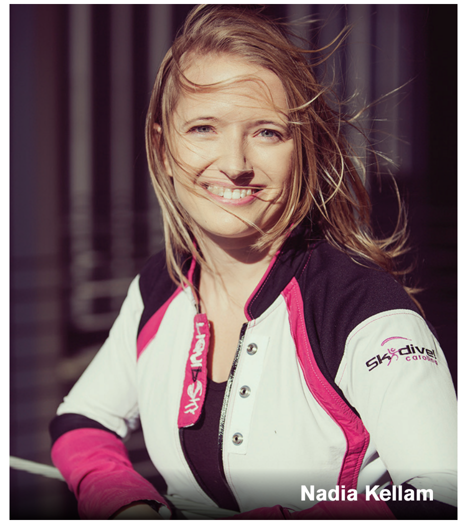
"Inciting a revolution in engineering education can start with creating a risk-seeking culture that helps and encourages faculty to step out of their comfort zone and try new approaches to instruction," believes Kellam.

One approach ASU's RED team champions in the Polytechnic School's engineering program is creating safe spaces where faculty members gather to reflect on their efforts to try innovative and new instructional methods. These groups provide a place where faculty members can receive constructive feedback and support for taking risks and trying to enable positive change, whether it's immediately successful or not.

"By empowering and rewarding risk-taking among faculty and students we create a culture of change agents [within the Fulton Schools] where everyone is able to modify and innovate the curriculum and learning experience, and this can lead to amazing transformation," says Polytechnic School Director Ann McKenna.

Kellam is taking a risk this semester by incorporating peer instruction and reflection throughout her mechanical engineering class.

"Even if it doesn't work perfectly I know it can be revised the next time around," says Kellam, who regularly invites faculty to observe her classes. She also takes time to observe other classes in an effort to learn from her colleagues' successes and failures.



Nadia Kellam

Kellam says ASU is well suited for this type of environment. She recognizes that fear of new things can be debilitating, but she also encourages faculty and students to not let fear distract them.

"As a skydiver, fear is a distraction that can make things more dangerous in the moment," says Kellam.

This fear can translate to teaching.

"If a faculty member fears bad evaluations then that fear can impact the way they teach and cause paralysis in their teaching methods — prohibiting them from taking risks that might benefit students," says Kellam.

She will be the first to admit she doesn't fit the typical professor mold.

"I do like showcasing that you can be an engineer and also have balance and other interests in your life," says Kellam

Her ability to maintain balance has been an inspiration to her colleagues and students.

Emily Coutts, a sophomore engineering student, says she was "impressed and surprised" to have a professor who is into extreme sports.

"It's beneficial when a professor can relate real-world examples to class work," said Coutts. "It helps me to visualize the material and think about how to apply it outside the classroom."

Kellam says her students might find her a little unusual, but when she explains engineering mechanics by talking about her firsthand experience with the statics and dynamics used in trapeze rigs, they pay attention.

More photos and videos online.

Left to right: Kyle Ness, John Nolan, Fabian Gadau, Rae Rutkowski, Troy Buhr, Stephen Stewart, Samuel Mokdad, Nicolas Corrales

VROOM! Ford Motor Company's engines keep ASU interns revved for future automotive careers

Three mechanical engineering students from the Fulton Schools spent their summer as participants in Ford Motor Company's Summer Internship Program, all working in some capacity with engine dynamics.

ASU is now numbered among Ford Motor Company's top-ranked Premier Schools, which brings additional funding for Career Services, increased Ford-sponsored campus activities and a designated recruiting team. For ASU, that includes Armando C. Chacon, Ford Motor Company Electrical Integration Manager. Chacon received his Master of Science in Electrical and Electronics Engineering from ASU.

"One of the things that makes Fulton Schools such an attractive recruitment source is that students are so active in undergraduate research and automotive engineering organizations," explained Chacon. "Involvement with programs like Formula SAE and outreach projects gives students opportunities to work in teams and develop problem-solving and leadership skills. ASU's programs are among the best in terms of recruitment. This year's ASU interns represent the best possible internship candidates."

Michael Thompson

Now a mechanical engineering doctoral student who just spent his fourth consecutive summer at the Ford Motor Company in Dearborn, Mich., Michael Thompson launched the Mechanical Flapping Bird Outreach Program during his senior year, which introduced middle and high school students to the basics of engineering design.

After Thompson founded the Micro Air Vehicle Club in 2014, Flapping Bird Outreach became a primary component and, under his leadership, MAV was named the Fulton Student Organization's Outstanding K-12 Program for 2016. He also was honored with an Outstanding Mentoring Award from the ASU Graduate Professional Student Association, and a paper about building mechanical flapping birds and arduino robotic cars as an education tool was presented at the Hawaii International Conference on Education in January.

Thompson, whose research in computational fluid dynamics has already resulted in a patent submission for a new scientific discovery in drag reduction, earned Ford Motors National Consortium for Graduate Degrees for Minorities in Engineering and Sciences (GEM) fellowship awards in 2013-14 and 2015-16 to support his graduate studies.

In summer 2016 he worked as a CFD external flow intern working with a team on the Ford F150 truck. Thompson says he's thriving in the program.

"I've learned so much on the job," declares Thompson. "If there's something I can't do myself, I can ping someone across the building and they are there with answers."

Ford's mission, "One Team. One Plan. One Goal" has been applicable to all of Thompson's engineering projects, he says. "Everything I'm involved in requires teamwork — whether it's in the lab, working with the MAV Club or serving as academic director for the Society of Hispanic Professional Engineers."

Thompson identifies many mentors at ASU who have helped him on his journey, including Fulton Schools Dean Kyle Squires, but especially acknowledges Professor Armando Rodriguez, an electrical and computer science engineer. "He was more than a professor," says Thompson. "He truly mentors his students."

Troy Buhr

Mechanical engineering senior Troy Buhr knew he wanted an internship with Ford and pulled out all the stops to get one. "I attended all of the career fairs and info sessions," he said. "I spoke to as many industry reps as possible – I think I was usually the last one to leave."

His hard work and dedication paid off when finally heard he'd been accepted into the program to work on this passion — the technology of electric vehicles.

Buhr said he was hooked when the company announced last year that it was moving beyond the hybrid market toward a battery-operated vehicle that will be competitive with longer-range electric vehicles entering the scene, like Tesla's. And sure enough, Ford has just allocated nearly $5 billion to electrified vehicle development that will be pulling in nearly 200 new jobs annually. "It's the fastest growing Ford department, according to the people I'm working with."

That team is the Electrified Powertrain Engineers Division. And while he's thoroughly enjoyed the immersion in his assignment, he also appreciated the series of one-on-one interviews with engineers from other divisions. The purpose of the meetings is to gain career insights from established professionals. "They were very generous in detailing what's been successful and what has not," says Buhr.

As team captain for ASU's Formula SAE team, Sun Devil Motorsports, Buhr has another connection to Ford. "It was a struggle to pull together funding for the national competition two years in a row," he explains. "Ford stepped in with a Vehicle Team Challenge Grant of $2,500 that helped us get to Nebraska. In addition, Ford gave $2,500 education grants to two team members, making Ford the team's biggest sponsor."

Samuel Mokdad

Samuel Mokdad

For mechanical engineering student Samuel Mokdad, being part of the team that works on the Ford Mustang engine was a dream — a dream that came true while working with a powertrain research team as a Ford intern this summer. In an assignment that is a bit unusual for an intern, Mokdad's group is working on the motor used in the Focus ST, Lincoln MKC and the Mustang.

When Mokdad attended his first Ford Company interview following a conversation with a recruiter at an ASU Career Fair, he was delighted to discover he was meeting with an "actual engineer."

"It was great to speak to someone who could understand and evaluate my technical skills," Mokdad explains.

Mokdad thoroughly enjoyed his "hands-on-engineering" assignment, working to reduce nitrogen oxide, hydrocarbon and particle mass while maintaining combustion stability. "Roughly 97 percent of emissions are caught by the catalytic converter, but the majority of the remaining three percent happen in the first 20 seconds of starting a cold engine, before the catalytic converter reaches activation temperature," Mokdad explains. "Until the catalytic converter kicks in, the engine is emitting harmful gases."

Mokdad's team investigated ways to mitigate the hydrocarbons and nitrogen oxides dispersed during those 20 seconds to meet upcoming SULEV30 EPA regulations in 2021. Mokdad went on to say that he was working on various techniques to optimize this combustion with cam timing and duration, injection timing and duration, piston bowl design, fuel injection pressure and spray pattern among many other means to not only meet, but exceed the EPA regulations.

Like all of the 2016 summer interns, Mokdad thoroughly enjoyed exchanging the desert heat for Michigan's summer weather. He says he'd love to go back as an intern next year — on the way to a coveted offer to participate in the Ford College Graduate Program.

Ford College Graduate Program

Nicolas Corrales, an ASU 2014 Distinguished Graduate in mechanical engineering who earned his master's in the Fulton Schools' 4+1 Program, joined the Ford College Graduate Program in 2015, and is now in the third of five rotations he'll go through before being assigned to a home department. Corrales has enjoyed his experience so much that he's joined the Ford recruiting team. "I had a great experience at ASU," Corrales said, "and see this as a way to continue my connections to the faculty and students."

Driven to succeed: ASU automotive team gearing up for strong comeback

Fulton Schools students on the Sun Devil Racing team participated in the three annual international Baja SAE off-road race car competitions — part of the Society of Automotive Engineers College Design Series competitions.

Despite debilitating hits to their vehicle's brake and transmission systems, a transmission oil leak, and a partially collapsed suspension system, the team kept fighting to get back in every race, earning respectable results in several categories of the competitions against teams from as many as 85 leading college and university engineering programs.

While major technical difficulties led to a lackluster overall score in the first competition, Sun Devil Racing bounced back to rank in 10th place overall in the California event in May — matching the second-highest overall result in the club's history — and finished strong in several categories in a competition in New York state in June. They also made it to the design finals in California — for the first time ever by an ASU Baja SAE team.

Photo by Ben Mecham

Engineering students among top performers at NASA's Human Exploration Rover Challenge

Four Fulton Schools students traveled to the U.S. Space and Rocket Center in Huntsville, Alabama to compete in NASA's Human Exploration Rover Challenge, which promotes research and development of new mobility technologies for crewed missions to other worlds.

The team returned after competing last year and improved their standing by 20 places in their second outing at the event.

The challenge tasks teams with designing and constructing a human-powered rover capable of completing a half-mile course that simulates extraterrestrial terrain.

ASU finished 13th out of 49 colleges and universities from across the nation, as well as international collegiate teams from Puerto Rico, India, Mexico, Germany and Colombia.

See more photos and video from the competition online.

Amelia Earhart Fellowship will propel student's aerospace materials research

Nithya Subramanian was one of 35 doctoral students named an Amelia Earhart Fellow for 2016-2017 by Zonta International, a global organization for women professionals.

The recipients, chosen from a pool of 121 applicants, represent 19 countries and include students from institutions such as Purdue University, Stanford University, MIT, Brown University and the University of Cambridge in the United Kingdom. The fellowship comes with a $10,000 award.

Subramanian received the fellowship for her research contributions in the area of lightweight multifunctional nanocomposites, which aim to improve performance when infused into the composite materials that make up aircraft, spacecraft and other aerospace technologies — critical for successful and safe outer space missions.

Body language interpretation research connects computer science student with ASL community

Have you ever received a text message in which the sender's tone was unclear? That's because crucial pieces of information are missing to fully understand the message.

To address this need, computer science doctoral student Prajwal Paudyal is working on SCEPTRE in the iMPACT Lab. SCEPTRE is a smartphone interface that uses two wireless armband sensors to take in ASL sign gestures to communicate via computer systems.

For his research efforts, Paudyal received the Spring 2016 Graduate and Professional Student Association (GPSA) Outstanding Research Award, which recognizes students who exemplify excellence in research and development.

Goldwater Scholars Barrett Anderies, Christopher Balzer and Kaleigh Johnson

Golden: Three 2016 Goldwater Scholars call the Fulton Schools home

In 2016, a mere 252 students were selected from a field of 1,150 nominees to be awarded a prestigious Barry M. Goldwater Scholarship — considered the premier undergraduate scholarship for mathematics, science and engineering majors. Out of those 252 exceptional recipients, four students hail from Arizona. Out of the four Arizonans, three are students in the Ira A. Fulton Schools of Engineering.

Over the last 10 years, ASU has become one of the nation's leading producers of Goldwater Scholars, with 27, outperforming lauded institutions such as Stanford, Princeton, Harvard and Yale. The latest honorees — Barrett Anderies, a double major in biomedical engineering and mathematics, and chemical engineering students Kaleigh Johnson and Christopher Balzer — all credit the extensive research opportunities for undergraduates in the Fulton Schools as a key to their success.

All three recipients are students in Barrett, the Honors College and participate in the Fulton Undergraduate Research Initiative, expanding their education with hands-on lab experience and independent and thesis-based research.

Anderies has conducted research as part of FURI for two semesters straight, working on quantitative analysis of electrocorticography data for rapid screening and identification of electrographic features in epileptic patients.

"My work has been focused on improving the performance of an experimental feature identification and extraction algorithm," he says. "I have managed to improve the algorithm performance to a point where automated analysis might soon be possible."

Anderies chose to pursue a biomedical engineering degree due to his interests in robotic prosthetics. He recognized that it was a field that required both biological and engineering expertise.

"Over the course of my studies I became more interested in the biological side of the problem, which involves integrating devices with the nervous system," Anderies says. "I started working in a neural engineering lab a couple years ago, and my experience there has reinforced my interest to pursue graduate studies in neuroscience. I hope to combine mathematical analysis, engineering tools, biological expertise and clinical experience to improve treatment of neurological disorders."

As for where Anderies will go next: "I find that I am always discovering new and interesting fields of study, and am still considering multiple career paths."

Johnson's FURI experience has furthered her chemical engineering knowledge and contributed to the progress of sustainable industrial engineering practices through research in synthetic biology — using microorganisms to produce compounds and materials for industry — in Assistant Professor David Nielsen's lab.

The choice of pursuing chemical engineering came easy to Johnson as it combined her favorite subjects of chemistry, math and physics in a versatile field that could take her anywhere.

She plans to pursue a doctorate in chemical engineering before working in industry.

"I want to implement synthetic biology into the production of chemicals and fuels," Johnson says. "I hope to make a significant impact in improving the sustainability of industrial manufacturing."

Balzer has taken part in FURI for three consecutive semesters, and plans on leveraging his award to continue focusing on research. Balzer studies nanoporous materials in assistant professor of chemical engineering Bin Mu's lab.

"The projects I have worked on focus on applying metal-organic frameworks into composite devices for gas separation and sensors," says Balzer. "I'm grateful ASU has a program like FURI to expose students to research early on."

Balzer hopes to continue his research in the future working on groundbreaking projects and is planning on attending graduate school. Regardless of where he ends up, Balzer is determined to make a difference in the world.

"My dream for my life is to contribute greatly to society," says Balzer. "That could mean making a large discovery in engineering or changing people's lives through volunteering. There's more than one way to make a difference."

Donor Honor Roll

$400,000 and above

Edward Kavazanjian Jr.
The Kern Family Foundation
TB Consulting, L.L.C.

$250,000 to $399,999

Avnet, Inc.
Del E. Webb Foundation
Texas Instruments, Inc.

$100,000 to $249,999

American Chemical Society
Anonymous
Anonymous
Anonymous
Kitchell
SRC Education Alliance
Verizon

$50,000 to $99,999

Anita Borg Institute
Anonymous
Associated Minority Contractors of America
Cache Valley Electric Company
E. Eugene Carter
Cisco Systems, Inc.
DPR Construction, Inc.
Electric Power Research Institute
Find Me Group
The Flinn Foundation
FORTA Corporation
Fujitsu Electronics America, Inc.
Google Research
Ravi Gorur
Corinne Hochgraef '65 and William Hochgraef '65 '68
Honeywell Aerospace
IBM Corporation
Oracle America, Inc.
Skoll Global Threats Fund
Southwest Patrons
State Farm Mutual Automobile Insurance Company
Suntec Concrete
UDC, Inc.
W.L. Gore & Associates, Inc.
Peter Wonka

$25,000 to $49,999

Alphacore, Inc.
Amway Corporation
Anonymous
Anonymous
Arizona Cactus-Pine Girl Scout Council, Inc.
The Autism Research Institute
Baidu USA L.L.C.
Beavers Charitable Trust
Bechtel Corporation
Cirrus Logic
Core Construction, Inc.
ExxonMobil Foundation
Kristine Friesen '01 and Cody Friesen '00
General Motors Corp Chevrolet Division
Henkel Corporation
Vidhya Iyer
Janie Eslick Johnson Trust
Laser Components DG, Inc.
Alexandra and Manuel Mora
Northrop Grumman Systems Corp.
O'Neil Industries, Inc.
Nokia Oyi
Robert Bosch North America
Venture Well

$5,000 to $24,999

3D Compression Technologies, Inc.
Achen-Gardner Construction, L.L.C.
American Endowment Foundation
American Subcontractors Association of Arizona, Inc.
Anonymous
Anonymous
Anonymous
Arrington Watkins Architects, L.L.C.
AT4 Wireless, Inc.
Aztec
Banicki Construction, Inc.
Judith and Barrie Barber
The Brook Family Foundation
Brown & Associates
Ann Bullington '80 and Paul Hermens
Brittney Cardinell '12
Monica Carey and Robert Carey '02
Centuri Construction Group, Inc.
Mary Dacquino and David Dacquino '81
Desert Diamond Casinos & Entertainment
Annamarie and Stephen DeTommaso '75
Mark Edson
FIRST
FNF Construction, Inc.
Ford Motor Company
Friends of the Earth Melbourne
Gammage & Burnham
Geosynthetic Institute
Gail and Edd Gibson
James F. Golder Memorial Scholarship Fund
James Grose '64
Karen Harbison
Hensel Phelps Construction Company
IASOTEK, L.L.C.
IM Flash Technologies, L.L.C.
Infinity Trading & Solutions, L.L.C.
Institute of Electrical & Electronic Engineers
International Test & Evaluation Association
Joseph Jason '73
JCJ Architecture
Elyse and Paul Johnson
Mark Kerrigan '74
Kiewit Infrastructure West Company
KUKA Robotics Corporation
Cuiping Li
Lockheed Martin
Markham Contracting Company, Inc.
McCarthy Building Companies, Inc.
Estate of Richard M. McDaniel
Douglas Montgomery
National Asphalt Pavement Association
Navajo Housing Authority
The O'Neil Foundation
Okland Construction Company
ON Semiconductor
Phoenix Cement Company
Phoenix Children's Hospital
Raytheon Company
RBG Construction Company, L.L.C.
Republic Services, Inc.
Cynthia Rodgers and Ronald Rodgers '77
Rosendin Electric, Inc.
Salt River Project
San Tan Ford
SDB Contracting Services
Semiconductor Components Industries, L.L.C.
Robert Sierks
Silver Shield
SmithGroup JJR
Florian Solzbacher
Stevie Sprague
Stanley Consultants Charitable Foundation
Stantec Consulting, Inc.
The Sundt Companies, Inc.
Sunland Asphalt
Sharon Thomas and Ronald Thomas '77, '84, '95
Time Warner Cable Shared Service Center
United Way of Southern Nevada
Charles Vermillion
The Vinnell Foundation
Wheeler Foundation
Julian Wright '95
Eun-Jeong Yi and John Aguilar
Lang-Sheng Yun '90, '96

Thank you

Every effort has been made to ensure the accuracy of this list. If an error or omission has occurred, please contact the Ira A. Fulton Schools of Engineering Development Office at 480-965-9646 so that we may acknowledge your support.

Teresa Clement with Ira Fulton at E2 camp, the introductory experience for new freshmen in the Fulton Schools

Looking back and paying it forward, Clement remains involved with Fulton Schools

It's not unusual to for alumni to stay involved with their alma mater. After all, college is formative time, full of great experiences and happy memories for many. Alumna Teresa Clement, on the other hand, has taken a commitment to the Ira A. Fulton Schools of Engineering to another level. She's virtually never left.

Upon graduating with a bachelor of science in materials science engineering in 2002, she went on to earn her doctorate, completing it in 2007. All the while, she served on ASU's Engineering Alumni Board, which now represents more than 65,000 engineering alumni. Her 15-year service on the board led to her current position as its president.

Since obtaining her doctorate, Clement's career and profile has risen rapidly at Raytheon Missile Systems in Tucson, Arizona. Starting as a process engineer almost a decade ago, she now works as a strategic technology manager for internal research and development. Despite the demands of her career, Clement has remained an active participant in the Fulton Schools community.

"The real advantage I always have from being engaged with the school is the connection with the next generation of engineers," says Clement. "My experience was so valuable that I felt I should give back and pay it forward."

One way Clement pays it forward is serving as a role model for young engineers and remaining active in recruitment, strengthening the academic-industry pipeline. Clement recalls one instance with an incoming freshman at E2 camp, which she makes a point of attending when possible. While playing basketball with a group of students, one struck up a conversation asking about her life and connection to ASU. She told him about her accomplishments, her work and where it all started: Central High School in Phoenix.

As a fellow graduate of Central High, the student was gobsmacked. "He asked me, 'You graduated from Central High and you have a Ph.D.?'" she recalls. "He was just blown away to hear someone had accomplished what I had coming from Central High."

It was actually late in high school that Clement joined an electric vehicle team at school, which sparked her interest in engineering. This influential experience helped determine her career path and it's since driven her to become active in organizations that engage children in STEM activities early.

"One place I do that is with *FIRST*® LEGO League as tournament director for the Tucson league," says Clement. "It's one of my passions right now, supporting an institution that fosters early interest in STEM and keeps kids engaged."

She's also the Arizona representative to the National Additive Manufacturing Innovation Institute's America Makes program, managing Raytheon's participation as Chair of the America Makes Roadmap Advisory Group. Clement represents industry partners on America Makes' Executive Committee after being elected to the committee in her second year working with the organization. In 2015, the organization recognized her with a Distinguished Collaborator Award.

As well as using her own experience to encourage aspiring engineers and contributing to early STEM education, Clement has leveraged her accomplishments and position at Raytheon to support Fulton Schools graduate recruitment. She attends both the spring and fall career fairs and participates in pre-screening students for internships and full-time positions within Raytheon.

Spending time with students reminds Clement of her undergraduate experience, which she attributes to her success at Raytheon.

"Even as an undergraduate I found a variety of ways to be involved, including serving as the National Director of Administration for the National Association of Engineering Student Councils (NAESC) and President and Director of Administration for the engineering student council," she says. "That's one of the things that helped me advance at Raytheon, building social skills through student groups."

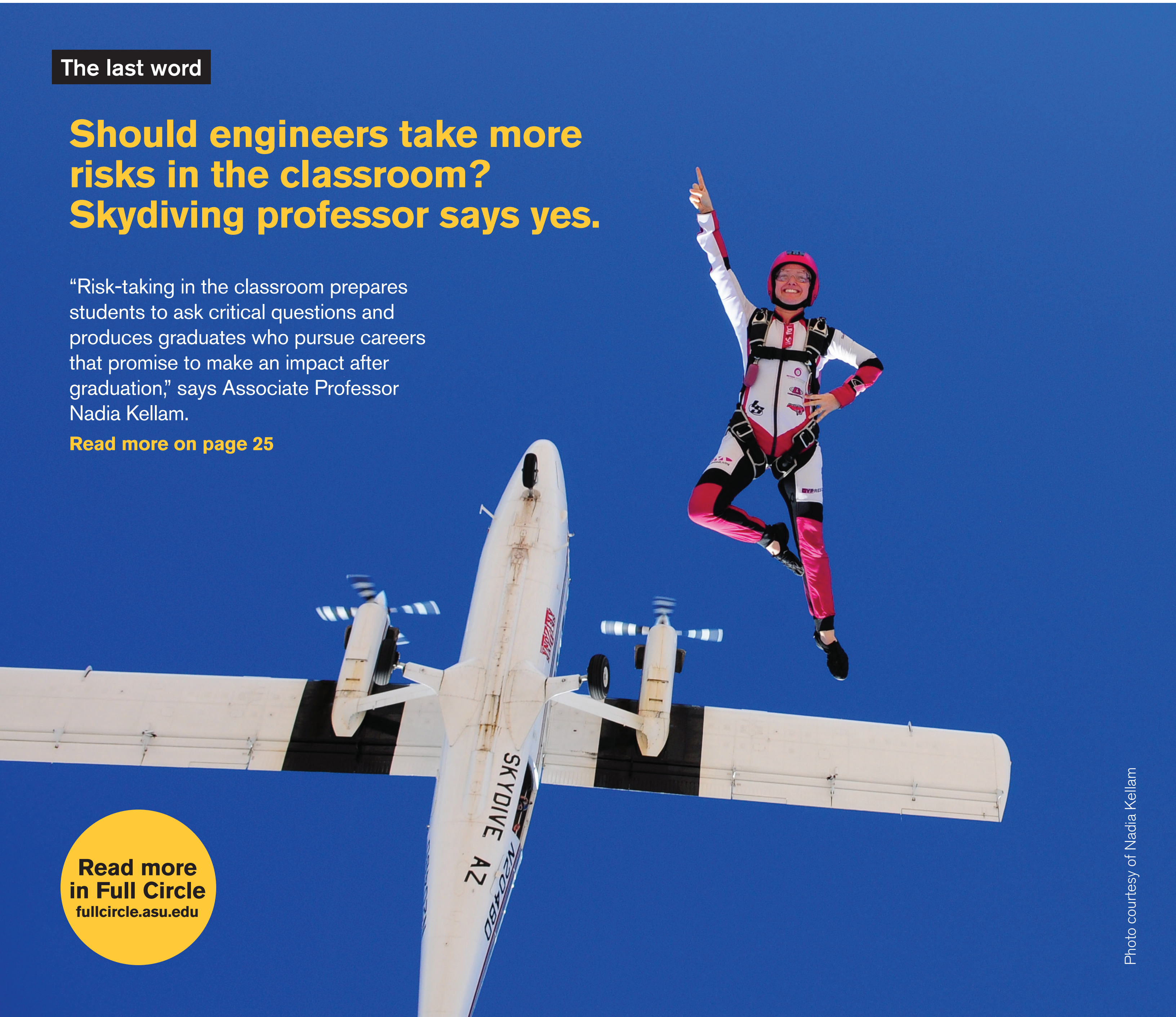
Regardless of what role, organization or cause she devotes time to, it all comes back to her overarching goal of "being a role model, showing people what's possible and what they're capable of accomplishing," she says.

But she's quick to point out that everyone's path is different, and she consistently reminds students to be agile to change.

"I like to give the advice, if you're in a position where you know you're not doing what you love, keep your eyes open, because your passion might be right next door," she says. "Be ready for that change."

IRA A. FULTON SCHOOLS OF engineering
ARIZONA STATE UNIVERSITY

PO Box 879309 Tempe AZ 85287-9309
engineering.asu.edu



The last word

Should engineers take more risks in the classroom? Skydiving professor says yes.

"Risk-taking in the classroom prepares students to ask critical questions and produces graduates who pursue careers that promise to make an impact after graduation," says Associate Professor Nadia Kellam.

Read more on page 25

Read more in Full Circle
fullcircle.asu.edu

Photo courtesy of Nadia Kellam