THE UNIVERSITY OF UTAH
COLLEGE OF ENGINEERING

RESEARCH REPORT 2018

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FROM THE DEAN

Progress Report: On the Road from Good to Great

Through a series of meetings in 2014, industry leaders, advisory board members and faculty department heads worked with me to develop a vision for 2020. Utah's tech economy and its unprecedented demand for technical graduates meant that the college would need to become larger. But how quickly and by how much? And most important, could the college accelerate its rate of growth without compromising quality?

We concluded that a growth rate of 5 percent per year was sustainable and would result in a College of Engineering that was one-third larger by 2020. The college would increase its footprint substantially within the university and better fulfill its mission to provide highly qualified technical graduates for Utah companies. But there were also challenges: We would need more space for the additional students and faculty, and the base budget would have to expand. Not growing was never a consideration.

With 2020 just two years away, it's time to report on our progress. Is the college on track to meet its targets, and are the assumptions that shaped our vision for 2020 still valid? Our 2020 target for enrollment was 6,318, compared with 4,715 four years ago. By 2017, we had reached a headcount of 5,513. The number of engineering degrees awarded in 2017 was 1,011, surpassing our target of 1,009 for 2020. Faculty headcount is currently at 192, just 48 positions short of our goal of 240.

On its current trajectory, the College of Engineering will meet or exceed the 2020 goals. The college has also made progress on space and funding. Engineering Initiative support from the Utah Legislature in 2015 and 2017, matched by the university, has helped us keep pace with base funding needs. At the same time, the successful renovation of the Rio Tinto Kennecott Mechanical Engineering Building added urgently needed space for the college's largest department. Ongoing renovation of the 58-year-old Merrill Engineering Building is creating space for many of the new faculty members and their graduate students.

Despite our progress, much remains to be done. At last count, 20 percent of the University of Utah's incoming students declared their intention to major in engineering or computer science, compared with just 7 percent in 2005. The pipeline is full of well-qualified students with the academic credentials to succeed in a rigorous technical program, yet the college is nearing capacity in class size and space.

Meanwhile, the state continues to demand more engineering and computer science graduates for its 26,000 job postings. From 2016 to 2017, tech-related job postings increased by an astonishing 42 percent. Net tech employment in Utah is 135,000, and the economic impact of the tech industry is an estimated $14.9 billion in direct contribution to the state's bottom line (10.25 percent of the total).

After four years of progress, not growing is still not an option. We will continue to focus on doing whatever it takes to be ready for 2020 and beyond.

Richard B. Brown
Dean, College of Engineering

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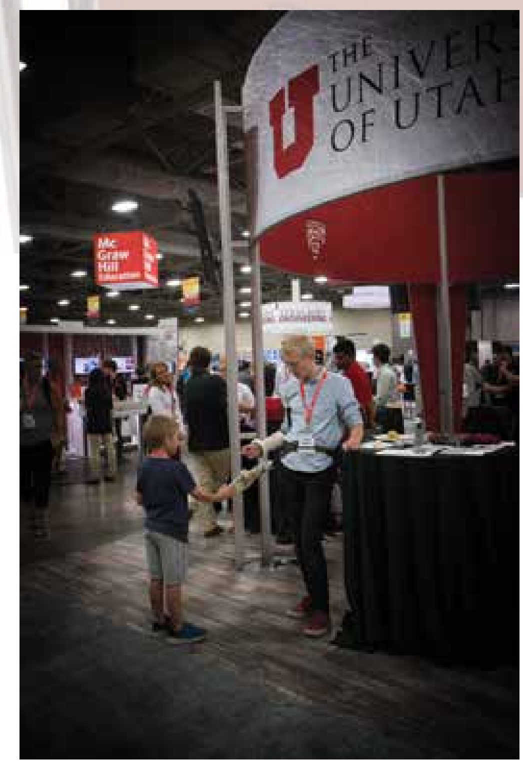
2018 ASEE CONFERENCE *highlights*

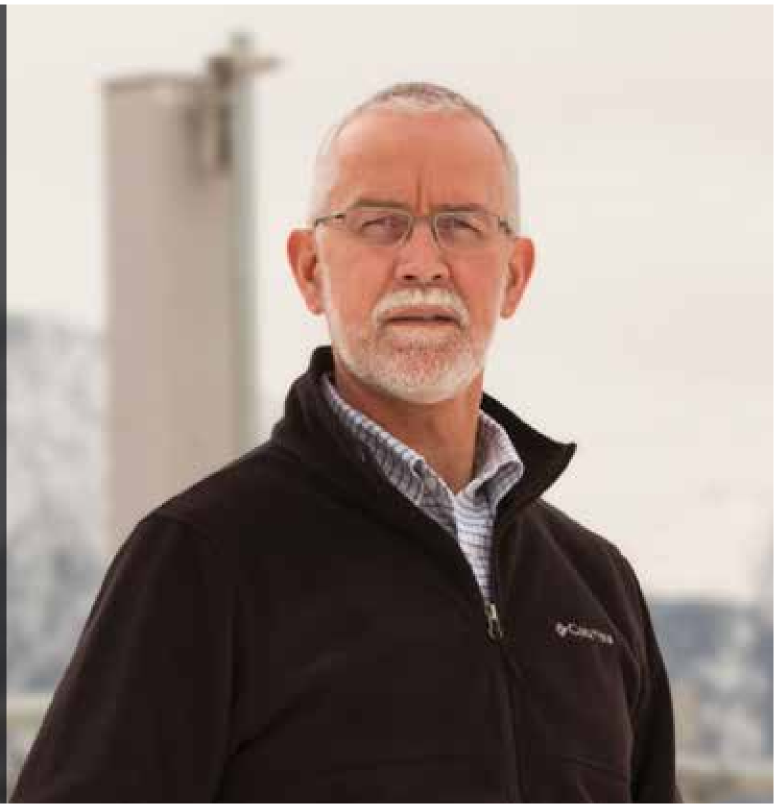


The University of Utah College of Engineering was proud to host the 125th American Society for Engineering Education Annual Conference & Exposition at the Salt Palace Convention Center June 24 – 27. It was an exciting and productive four days for more than 4,300 engineering education professionals who came to the magnificent mountains of Salt Lake City. And to cap off the successful conference, the college hosted a one-day workshop on commercializing engineering research that was packed with ideas for universities that want to become more entrepreneurial. We thank all of those who came to visit our beautiful state as well as the college's booth in the exhibit hall, and we hope to see you again!

THE LEADING EDGE

A "LIVING LABORATORY"

The future's most cutting-edge research in mobile and wireless communications, from faster cellphone connectivity to networking smart cars, will be tested on a new platform being built at the University of Utah and in Salt Lake City. Researchers from the U's School of Computing (led by associate professor Kobus Van der Merwe), along with Rice University, are building a "living laboratory" for mobile and wireless technologies called Platform for Open Wireless Data-driven Experimental Research (POWDER) that involves installing "nodes" or wireless network base stations on the University of Utah campus and along a two-mile corridor of downtown Salt Lake City. With this platform — from a $17.5-million NSF grant — companies, universities and government labs can test their technologies on an open, real-world wireless network.



POWER UP

University of Utah electrical and computer engineering assistant professor Masood Parvania is building a new laboratory to develop technology that would help communities get their power back online faster in the wake of devastating events such as Hurricane Maria, which left nearly all of Puerto Rico without power. Parvania, who received a $2-million grant from the U.S. Navy's Office of Naval Research, will develop and test technology for microgrids — smaller, more localized versions of a city's power grid that could provide backup electricity in a catastrophic situation, including a cyberattack.

GOING FOR THE GOLD

U.S. Nordic Paralympic athlete Sean Halsted needed a new sitski to compete in the 2018 Winter Paralympics in Pyeongchang, South Korea, and a team of University of Utah mechanical engineering students accepted the challenge. The six-person team, led by U mechanical engineering assistant professor Michael Czabaj, used computer simulations and a special composite material to build a sitski that was lighter but at least as strong as traditional sitskis. The result was equipment that surpassed everyone's expectations, according to Halsted's coach. He came in 22nd and 14th in his first two races and finished 23rd in the 7.5-km race.

STUDYING FLUID INTERACTIONS

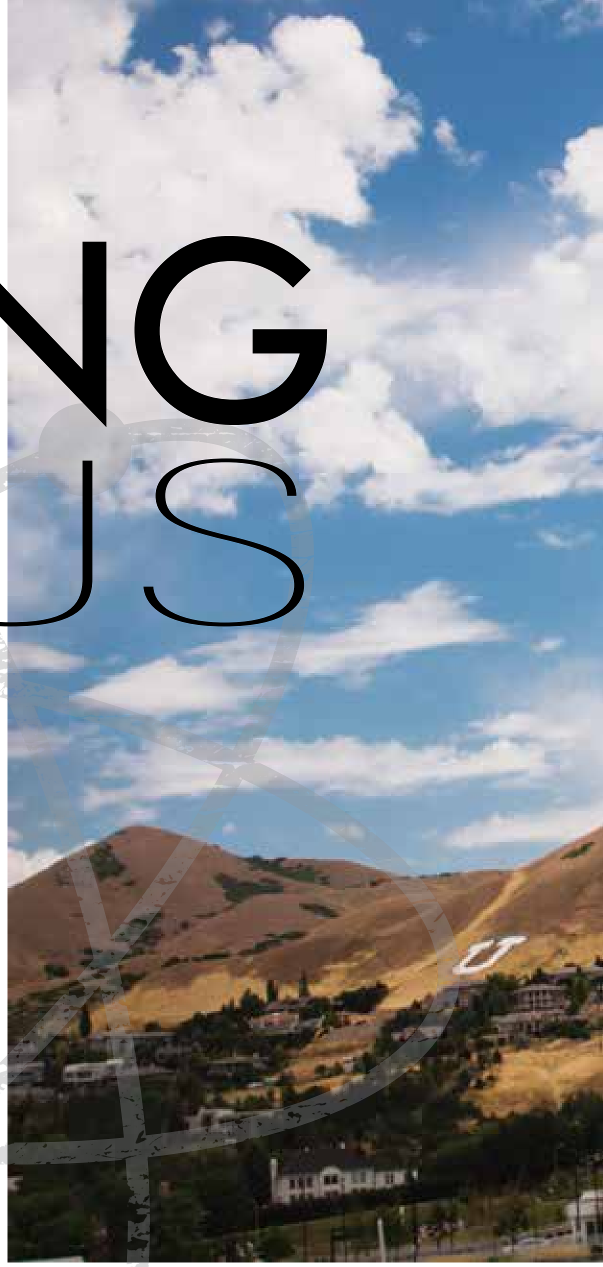
The University of Utah's College of Engineering and College of Mines and Earth Sciences have received a $10.75-million DOE Energy Frontier Research Center grant to create the Center for Multi-Scale Fluid-Solid Interactions in Architected and Natural Materials and study how fluids interact with porous solids. This vital research could benefit the future production of oil, gas and other energy resources, including figuring ways to use less water in hydraulic fracturing.

THE BREAKING POINT

To better understand why many elderly people are prone to break a bone in a fall, perhaps doctors and researchers should look at the human skeleton in much the same way civil engineers analyze buildings and bridges. In a new study funded by the Swiss National Science Foundation , U mechanical engineering assistant professor Claire Acevedo says the bones of an older person become more susceptible to a break due to repeated stress from everyday activities such as walking. Old bones gradually lose their mechanical properties, their ability to self-repair and to recover bone quality to prevent the formation of a fracture.

DIZZYING SOUNDS

University of Utah biomedical engineering professor Richard Rabbitt and doctoral student Marta Iversen have discovered why certain people experience dizziness when they hear a particular sound, such as a musical tone. For patients with semicircular canal dehiscence, there is a hole in the bone that the inner ear is encased in, and certain acoustic tones, even a high-pitched voice, can cause the brain to receive the wrong motion signals. As a result, according to the National Institutes of Health-funded research, the patient can experience dizziness and vertigo.



INSPIRING GENIUS

The late James LeVoy "Jim" Sorenson built a biomedical empire around the world's first disposable surgical mask after observing doctors' dissatisfaction with the poorly-laundered cloth variety that was available at the time. What followed the mask was a successful line of disposable catheters and other surgical devices Sorenson conceived to solve clinical problems while improving patient care and reducing cost. Many called him a genius.

Today, University of Utah bioengineering associate professor Bob Hitchcock, a frequent collaborator of Jim's at Sorenson Medical, is inspiring a new generation of geniuses in the building that also bears the Sorenson name. Hitchcock and his team direct an innovative program in biomedical device development that pairs undergraduate and graduate engineering students with clinicians in the ultimate problem-solving experience.

According to Hitchcock, "every good solution begins with a good problem." In his bioDesign class for undergraduates, the clinicians supply the ideas, clinical relevancy and mentoring while the student teams develop requirements, build prototypes and conduct testing. All of the projects are based on new ideas or improvements for products and are disclosed to the University of Utah's technology commercialization office as new inventions.

At the graduate level, the bioInnovate track trains students from engineering, medicine, business and law in clinical problem identification, medical device innovation, and commercial translation; all within the regulatory framework of the Food and Drug Administration. Students find themselves immersed in clinical environments where they learn to observe procedures, how medical devices are used, and interact with patients and clinicians to uncover unmet clinical needs. Students then translate these unmet needs into medical device concepts that are refined for commercial potential.

Hitchcock's path to the University of Utah faculty was non-traditional. He was born in Japan and raised in Hong Kong, experiencing the British school system through age 10 when his family relocated to the New York suburbs. After completing a degree in chemistry with courses in mechanical engineering, he went to work in the oil and gas industry designing sensors for down-hole oil drilling. "It turns out, the same materials that can survive the harsh environment of a deep well," Hitchcock explained, "are also biocompatible." He was recruited by Becton Dickinson in Utah and later moved to Sorenson Medical where working alongside Sorenson had a profound impact on his life.

Both the bioDesign and bioInnovate programs are considered high-impact learning experiences because the students work in teams to complete design projects. The projects in these programs are different. Rather than being another laboratory exercise that has been previously worked out, these are poorly defined real-world problems. Hitchcock believes that this creates a bit of discomfort among the students at first.

"The process of design development is often messy, chaotic and disorganized," he said. "We take high-achieving students who are used to finding the right answer and put them into a situation that is very uncomfortable compared with the usual academic exercise." The problems are poorly defined on purpose, forcing students to think their way through to a solution, often asynchronously. Meanwhile, Hitchcock provides a high-level roadmap to the design and development of bio-medical devices using FDA guidelines.

"As engineering students, they are inclined to rush through to a solution," he said. "We hold them back at the design input stage so that they learn to observe and gather as much information as they can. The teaching mission is not so much about the project, but about the project as a vehicle for understanding the design process." His ultimate goal is for students to understand that "design is both a noun and a verb" and that the process of design, or design thinking, can be applied to many types of problems.

With multiple commercially-successful products spun-out of his own research, Hitchcock's favorite projects are ones that help inform medical treatment decisions and improve clinical care. His intra-abdominal pressure-transducer was developed as a research tool in collaboration with a University of Utah gynecologist. While it hasn't resulted in a commercial product, the transducer produced valuable data that helped to dispel the myth that all post-partum exercise is equally dangerous in the first few weeks following delivery. "Information is a powerful tool for improving outcomes-based medicine," said Hitchcock.

In his mission to prepare a new generation of geniuses, Hitchcock hopes to dispel a popular myth about bio-innovation. "There are very few 'ah-ha' moments in bio-design development. Most of the work we do is very mundane," he said. "I've developed a number of successful medical products, but by far the best product I've ever worked on are my students. I attend every convocation because, for me, graduation is my 'new product launch,' and I want to be there to celebrate with the students, families and faculty."

A MATERIAL WORLD

Engineering innovation doesn't always follow a straight line. A discovery in one discipline may lead to a breakthrough in another. The need to solve a pressing problem for industry may propel new discoveries with broad implications. Perhaps nowhere is this more apparent than in the field of materials research.

For University of Utah materials science and engineering professor Ling Zang, the turning point came 15 years ago with a call from the U.S. Department of Homeland Security.

While researching how molecules behave within nanomaterials, Zang had discovered a new type of nanofiber composite for chemical sensing. When Homeland Security asked him if his fibers could be used to detect explosives, he admitted that while the idea hadn't occurred to him, he could see that the notion held promise.

His discussions with Homeland Security led Zang to shift the focus of his research. Ultimately, this application-oriented approach helped Zang garner more funding and launch products based on his work. It also led to collaborations with the Environmental Protection Agency on real-time air monitors, and most recently, with the University of Utah School of Medicine, where he is working on breath-sensors to detect cancer.

Today, young scientists in materials research at the U continue to create applications and tools that are advancing the field as they work on composites for stronger, lighter products; more reliable vehicle and aircraft parts; and new materials for medical and electronic devices.

Taylor Sparks, a U assistant professor of materials science and engineering, is developing a computer program that identifies the optimal material for a specific application. U mechanical engineering assistant professor Ashley Spear (pictured, above) is studying the effect of fatigue in aerospace metals such as aluminum and aluminum foam and is analyzing 3D-printed metal parts. She said the college promotes a multidisciplinary approach that includes collaborations with other disciplines and outside manufacturers leading to advances in materials, design and engineering.

"Manufacturers, experimentalists, and modelers have a very symbiotic relationship," she said. "Each is necessary to achieve meaningful design objectives: modelers provide predictive tools that can be used to probe large materials-design spaces; experimentalists provide characterization data that are necessary to develop and validate the models; and manufacturers provide the means of physically realizing the material. Information from each researcher is used to help guide the decisions of the others so that the group collectively pushes the boundaries of materials exploration in a realistic and achievable manner."

Spear is involved in a collaborative project to build models that will predict the performance of new materials in industrial ap-

plications. For example, if one can predict how a variable like temperature will impact the strength of a material, they can decrease the time it takes to bring a new product to market.

"It will improve both the efficiency of new materials coming onto the market and the safety and reliability of products made with those materials," Spear said. "No one wants to put a new material out there that's not going to be reliable."

U mechanical engineering assistant professor Michael Czabaj is researching the performance of carbon fiber reinforced composites and ceramic-matrix composites to understand how and why they fail. Because it's not entirely clear what causes composite materials to fail, Czabaj said, manufacturers must currently overbuild an aircraft, for example, in the interest of passenger safety, adding to the plane's cost, weight, and fuel consumption.

This is especially true of space transportation, Czabaj said. If manufacturers understood exactly what would cause a specific material to fail, they could be more precise in their designs. "Perhaps someday, it will cost less to go into space," Czabaj said.

Collaboration with the private sector is continually inspiring new lines of research. Sparks was approached by a computing company in response to a review article in which he concluded that humans can be inefficient at predicting which materials work for given applications.

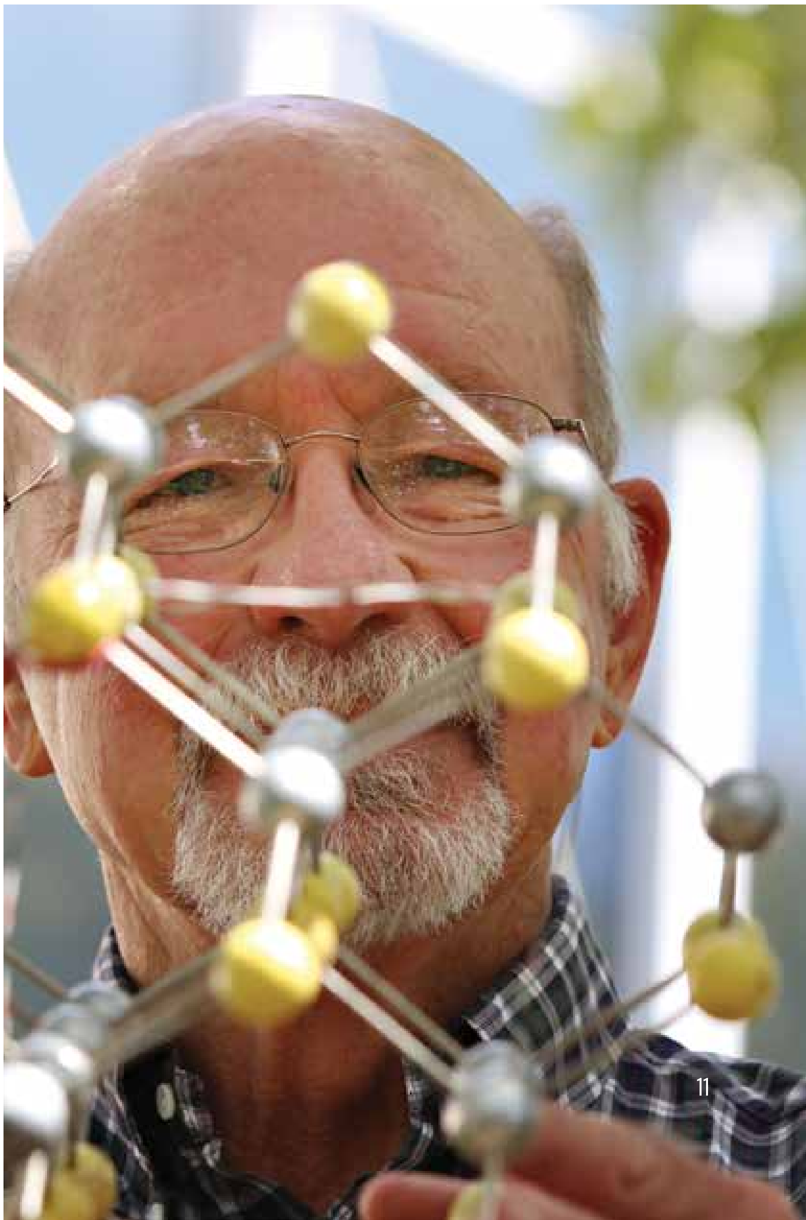
The company proposed a swap — if he gave them access to his data, Sparks said, they would teach him about machine learning.

Machine learning, Sparks said, is a new field with huge potential for materials science. Currently, discovering new materials for an application can be painstakingly slow. The premise behind Sparks' work is fairly simple. Scientists feed data into a computer program that analyzes correlations between various materials. The program then suggests new combinations that are likely to meet certain criteria, like strength or conductivity.

Sparks has already seen some success. After receiving a grant to identify new super-hard materials, he used machine learning to identify two promising compounds in less than a year. "There will always be room for specialization, but the discipline at the forefront of bringing specialties together is materials science," Sparks said. "New technologies, new data, and new challenges are fueling discoveries in materials science."

These exciting projects reflect a long tradition of research excellence at the U's College of Engineering in the field of materials science. U materials science Distinguished Professor Gerald Stringfellow (pictured, below) pioneered the efficient manufacturing of materials for light-emitting diodes and high-efficiency solar cells. Distinguished Professor Anil Virkar developed solid-oxide fuel cells that convert hydrogen, reformed methane or carbon monoxide directly and efficiently into electrical energy. And the late Distinguished Professor Richard Boyd is well known for his computer modeling of polymers.

Engineered materials are the building blocks of high-tech products. The techniques being employed by University of Utah faculty to better understand material properties and to accelerate the development of new materials will continue the U's legacy of seminal contributions. "We definitely have a group of young, high-quality faculty members with the potential to become the material science stars of the future," said Virkar.



SOMETHING IN THE WATER

According to University of Utah civil and environmental engineering associate professor Jennifer Weidhaas, the technology exists to treat wastewater to ultra-pure standards. The cost, however, would be astronomical, and consumers would balk at paying high monthly bills to purify water to drinking-water standards. Instead, this wastewater is treated and used for secondary purposes or for irrigation, an approach that is slowly becoming accepted by the public at large.

"As an environmental engineer," Weidhaas commented, "it amazes me that we can take wastewater and treat it to safe levels for reuse in irrigation systems in just hours. Wastewater reuse provides a valuable and economical water source, reducing our use of drinkable water from the canyons. Our research helps us understand how to economically treat the wastewater while ensuring it is safe for the intended purpose."

Growing up in a small rural community in Idaho, Weidhaas was well aware of water as a precious resource. Despite the large watershed of the mighty Snake River, much of Idaho is arid. Many states, like California and Nevada, already restrict water use by consumers during summer months and periods of drought. For these states and the world at large, recycling every drop of wastewater is both a practical and economic necessity. But who determines the standards for secondary water used on farms, orchards and gardens? What are considered acceptable levels of pathogens, and when is it safe to harvest the crops?

To prepare for her career in water research, Weidhaas completed a bachelor's degree in bio-resource engineering at Montana State University, followed by a master's and doctorate degree in civil and environmental engineering at the University of California, Davis with an emphasis in biotechnology. She previously worked at Idaho National Laboratory and later North Wind, Inc., an environmental services company in Idaho Falls. She also was an assistant professor in civil and environmental engineering at West Virginia University.

At the University of Utah, Weidhaas' research and teaching interests have focused on biological processes and the fate and transport of contaminants and microorganisms in the environment. Some of her recent projects include the evaluation of emerging contaminants in environmental systems, chemical spills impacting water resources and bioremediation of hazardous materials. She also conducts research in environmental microbiology including microbial source tracking, the development of massively parallel pathogen detection methods, and evaluation of microorganism fate in environmental systems.

In their current research, Weidhaas and her colleagues employ a combination of monitoring technology and direct detection of waterborne pathogens. Multi-target gene microarrays are used to simultaneously identify waterborne pathogens and aid in determining sources of contamination. "Public utilities in the U.S. are doing a good job of keeping water safe," she said. Their research has shown, however, that even well-treated secondary water may still carry waterborne pathogens such as viruses, bacteria and other harmful organisms. Despite these pathogens, the water may still be used safely for a variety of purposes.

"We have funding from the U.S. Department of Agriculture in conjunction with Utah State University to look at human health impacts from using reclaimed wastewater for agriculture in Cache Valley (an area in northern Utah)," she said. "In this project we are evaluating the safety of wastewater reused for irrigation in urban environments. Ultimately, we will provide guidance to the State of Utah and its residents on the most appropriate and safe uses of reclaimed wastewater or secondary water."

With support from a National Science Foundation CAREER award, Weidhaas is also focused on advancing pathogen detection and quantitation in water systems globally. She recently visited Hyderabad, Pakistan, with colleagues from the U through a project funded by the United States Agency for International Development (USAID) and the U.S.–Pakistan Center for Advanced Studies in Water (USPCAS-W). "During that trip we evaluated the city's water distribution system. We were mapping the distribution of fecal pathogens, antibiotic resistant pathogens and viruses in the water people were drinking. Ultimately, we will determine the most likely sources of contamination in the system and recommend sections of the distribution system that need to be rehabilitated," explained Weidhaas.

When asked what makes her approach unique compared with others in the field, Weidhaas responded: "I am an engineer, a microbiologist and a risk assessor. These three areas inform my work equally. As such, we take projects beyond a gee-whiz widget or new method and we work to change policy and public opinion to ultimately improve human health and the environment."

'FORGE'ing ahead

University of Utah Energy & Geosciences Institute research scientist and civil and environmental engineering research professor Joseph Moore (right) and chemical engineering associate professor John McLennan (left) are leading a team building the FORGE geothermal research laboratory. It will be at the forefront of creating new technologies for this growing renewable energy resource.

A key to developing future technologies in geothermal energy lay thousands of feet beneath the dirt and rubble in a stretch of land in central Utah. Near the small town of Milford in Beaver County, the University of Utah will construct one of the world's leading geothermal research laboratories.

In a five-way competitive process that lasted three years, the university's Energy & Geosciences Institute (EGI) was awarded a five-year, $140-million grant from the U.S. Department of Energy to develop the Frontier Observatory for Research in Geothermal Energy (FORGE). The laboratory will be at the forefront of research into this green energy resource, which uses heated water from below the Earth's surface to create steam that turns turbines for generating electricity.

"This laboratory will provide a unique opportunity for researchers around the world to develop and test new technologies for accessing geothermal resources," said Joseph Moore, an EGI senior scientist and research professor in the College of Engineering's civil and environmental engineering department who is leading the university's FORGE team. "With technology development, geothermal resources beneath our feet offer the potential to help meet the nation's energy needs."

The laboratory will conduct research into a new Enhanced Geothermal System that involves drilling into low-permeability, hot granite. Two wells will be drilled to a depth of about 7,500 feet and up to 12,000 feet in length on state land. These wells will be used by researchers to conduct experiments for improving geothermal energy extraction. After the first well is drilled, it will be hydraulically stimulated to create fractures in the reservoir rock, and scientists will monitor the growth of those fractures. The next year, the second well will be drilled into the fractures created around the first well.

Current geothermal power plants use underground water that already is heated from existing fractures. In an Enhanced Geothermal System, which is not used commercially yet, water is pumped down the first well and into the cracks that interconnect the two wells. This water is heated as it passes through the 400°F thermal reservoir. The hot water is circulated up the second well and flashed to steam at the surface or passed through a heat exchanger. The steam powers turbines and generators.

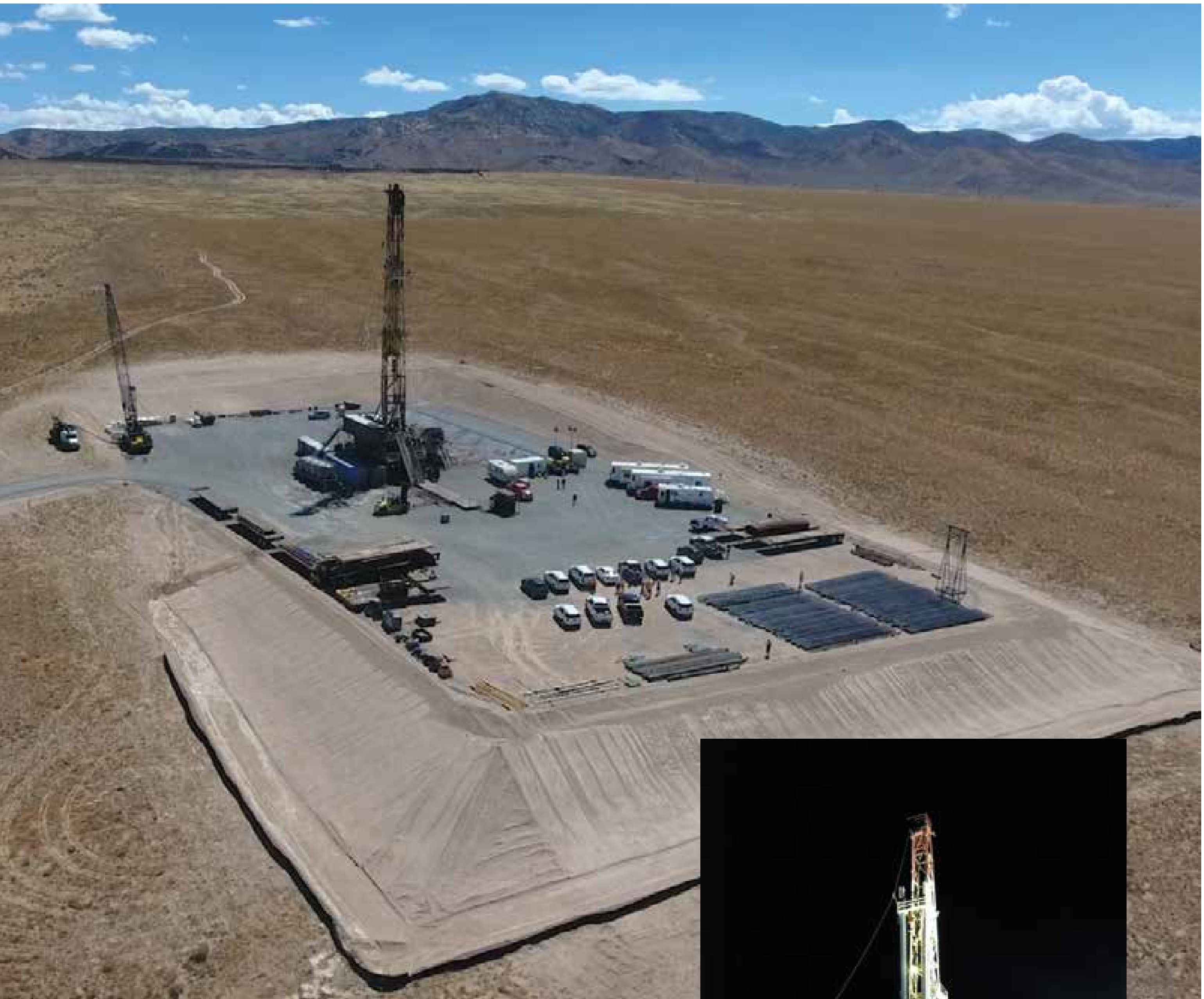
This laboratory is not designed to produce electrical power per se, said University of Utah chemical engineering associate professor John McLennan, a member of the FORGE management team. "This is a field laboratory intended to try and understand techniques for growing these fractures and for drilling," he said.

The information that the EGI team hopes to acquire from the FORGE laboratory could help energy companies create future geothermal sites that are more efficient and in areas of the country previously not thought to be practical.

"Currently, we can generally only extract geothermal energy roughly in the western part of the U.S. and maybe in the Gulf Coast," McLennan said. "The attractiveness of this laboratory is that it lays the groundwork for geothermal energy production in other parts of the country."

The Utah land chosen for the FORGE site is perfect for the project, according to Moore and McLennan. The subsurface temperature fits the Department of Energy's requirements, and there are no endangered species in the area. The physical and mechanical properties of the rocks are ideal for reservoir creation, the groundwater is non-potable, and the area is relatively aseismic.

The FORGE team also assembled some of the world's top scientists and engineers to develop and run the laboratory. EGI has been a leader in developing geothermal technologies for more than four decades. The institute is collaborating with faculty members from the University of Utah's College of Engineering and College of Mines and Earth Sciences, as well as researchers from the Utah Geological Survey. The team includes other universities, national laboratories and experts in the geothermal, oil and gas industries.



The team has been working with SITLA (School and Institutional Trust Lands Administration) and private landowners to construct the facility within an already-established renewable energy corridor near Milford. This location is home to two geothermal plants, a wind farm, a solar field and a biogas facility. Moore and McLennan said a goal is to build a visitors' center next to the corridor to help promote these important renewable energy resources.

"Receiving the award validates this as the best site in the country," McLennan said. "And it establishes that there is a strong management team behind it."

A major challenge for engineers is keeping distributed and internet-tethered devices such as battery-powered weather or pollution sensors running for long periods of time when placed in remote areas including forests, farms and mines.

University of Utah electrical and computer engineering associate professor Hanseup Kim is tackling the problem through nano-scale sciences, discovering a novel solution in the least likely of places — his front yard. His research is being funded by the DARPA Near Zero-Power Electronics (NZERO) program.

"It was in the summer and very dry, and I was curious about how the rainwater forms a well and if there was a way we could intentionally design the land so we could form a water well to one particular area in need," he remembered.

After studying geology and chemistry books for his yard problem, Kim discovered a natural phenomenon called "percolation"— the statistical behavior of multiple random rain drops that ultimately form a water well. He then applied this concept to powering portable sensors and the statistical behavior when they detect target molecules such as gas molecule concentrations. Kim has created an electrical switch to turn on the sensor only when it detects a chemical. But like raindrops that form a larger pool of water, this main switch is also comprised of an array of smaller switches measured in nanometers. If enough of the nano-scale switches detect the target, they statistically produce a decision to tell the main switch to connect and power on the sleeping sensor.

Usually, a sensor is always powered on while it is "sniffing," and that ultimately puts a drain on its battery. But Kim has designed his "percolation switch" for portable sensors that keeps the device in a near-zero-energy state, using only 100 picowatts (a picowatt is one million millionth of a watt) of power in "sleep" mode until it detects what it is designed to find. Once it does, it turns on, takes the measurement and sends the data to a network. Then it turns off again until the next time it senses the chemical.

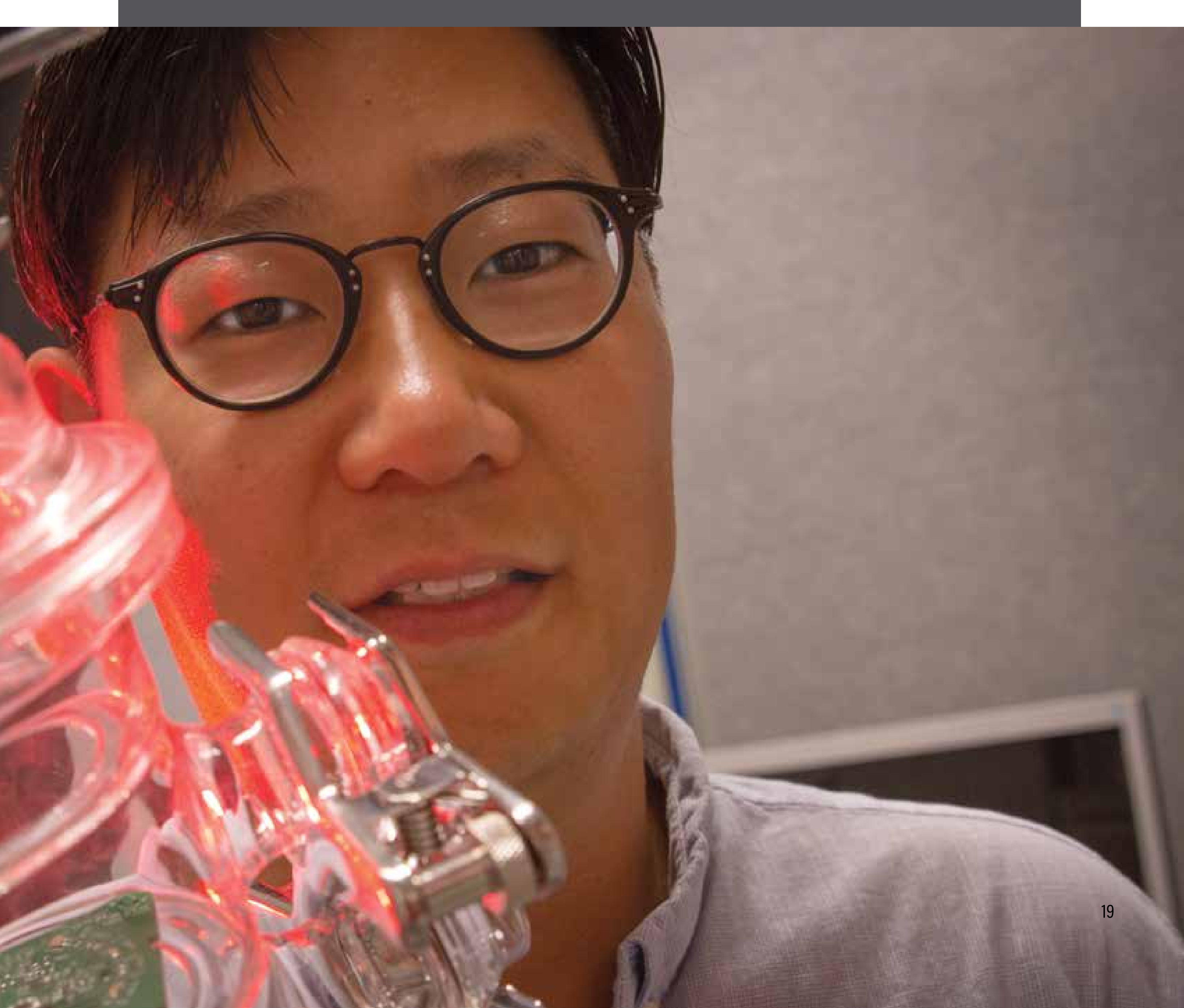
"When we have multiple switches connected in such a way, then multiple molecules can be detected, and this collective switching becomes more statistically reliable," Kim said. "Fewer random events will affect the overall behavior."

The result, he said, is creating a portable sensor that is both accurate and can last up to several years in the field before changing the battery as opposed to just a couple of days. That's critical for placing sensors in hard-to-reach areas for, say, atmospheric measurements or for chemical warfare. It would also be a boon for fire sensors placed deep in forests or water sensors used in pipes to detect unwanted toxins. Ultimately, Kim believes this can result in an abundance of data in hard-to-reach areas, such as information about toxic gases from wildfires, the spread of a virus, even attacks of herbivores in farms.

It's challenges like these that drew Kim to engineering. He received his doctorate in electrical engineering from the University of Michigan and has been with the University of Utah for 10 years.

"In graduate school, I was challenged to explore new areas and push the envelope of our knowledge," he said. "That desire to explore is something I have always been fascinated by and enjoy."

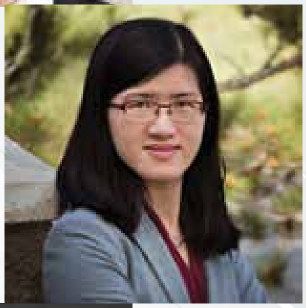
STAYING POWER



NEW FACULTY

Tamara Bidone
Assistant Professor, Biomedical Engineering
Computational modeling and simulations of biological systems, Brownian dynamics simulations of the cell cytoskeleton, particle-based models of molecular, cellular and tissue biomechanics, multiscale models of cell adhesions.

Jan Kubanek
Assistant Professor, Biomedical Engineering
Noninvasive diagnoses and treatments of brain disorders, neural engineering, neuromodulation, systems neuroscience.



Yunshan Wang
Assistant Professor, Chemical Engineering
Ultra-violet plasmonics enabled label free biosensors, active UV plasmonic devices, novel UV transparent materials for biomedical applications.

Edward Cazalas
Assistant Professor, Civil and Environmental Engineering
Nuclear and radiation physics, radiation detection and measurement, nuclear security and non-proliferation, radiation effects, dosimetry, nanomaterials, Monte-Carlo simulations.

Nikola Marković
Assistant Professor, Civil and Environmental Engineering
Operations research, data science, interface of optimization and data.

Tara Mastren
Assistant Professor, Civil and Environmental Engineering
Nuclear medicine, isotope production, targeted radiotherapy, nuclear reactions, nuclear forensics, radiochronometry, actinide and lanthanide separations, radiochemistry, spent nuclear fuel reprocessing.

Carlos Oroza

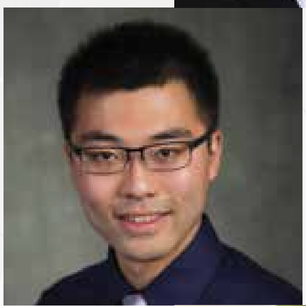
Assistant Professor, Civil and Environmental Engineering

Cyber-physical systems, machine learning, sensor networks, water resources.

Xuan "Peter" Zhu

Assistant Professor, Civil and Environmental Engineering

Intelligent infrastructure, geological storage of CO2, structural health monitoring, flexible and stretchable devices, nondestructive evaluation, experimental mechanics, data mining.



Mingxi Liu

Assistant Professor, Electrical and Computer Engineering

Power and energy systems, optimization and control, cyber-physical systems.

Yu Xiang

Assistant Professor, Electrical and Computer Engineering

Statistical signal processing, information theory, machine learning, and their applications to neuroscience and computational biology.

Jacob Hochhalter

Assistant Professor, Mechanical Engineering

Structural materials, finite element analysis, digital image correlation, uncertainty propagation, fatigue and fracture.

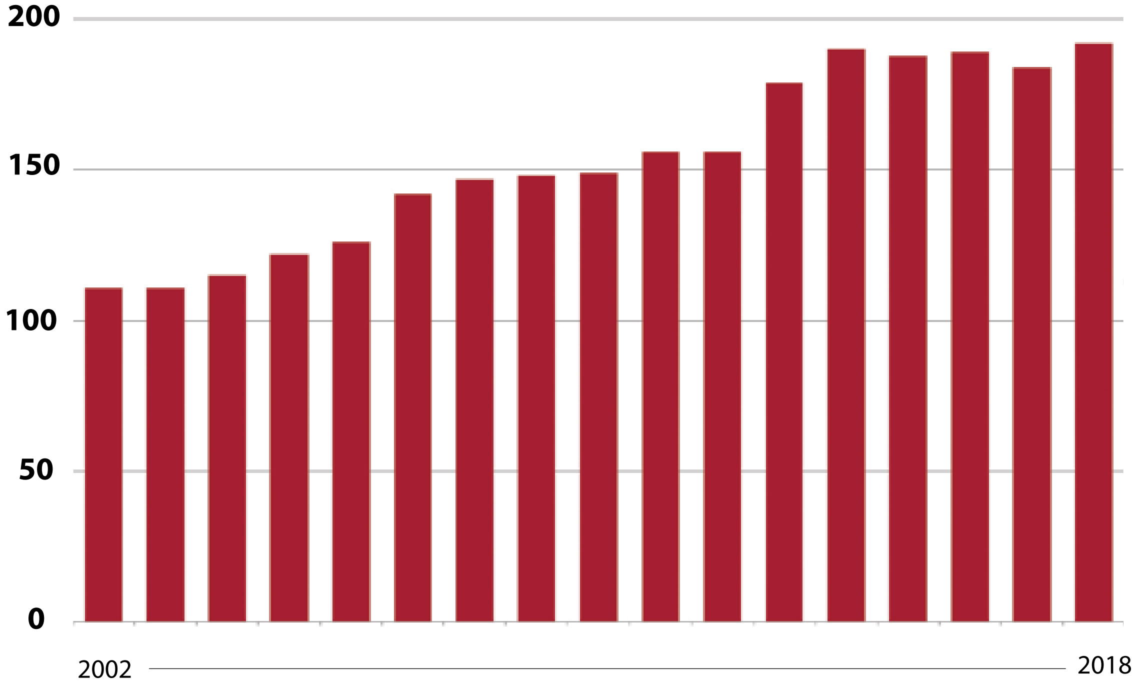
Sameer Rao

Assistant Professor, Mechanical Engineering

Multiscale heat and mass transfer, energy conversion and storage, water harvesting and purification, thermal management.

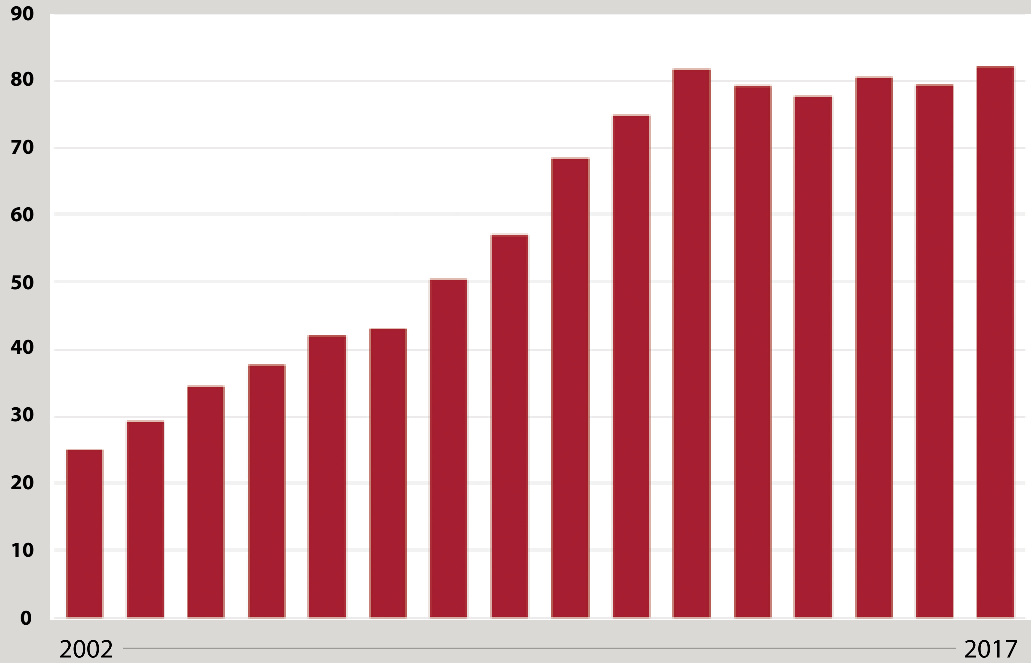
BY THE NUMBERS

TENURE TRACK FACULTY GROWTH



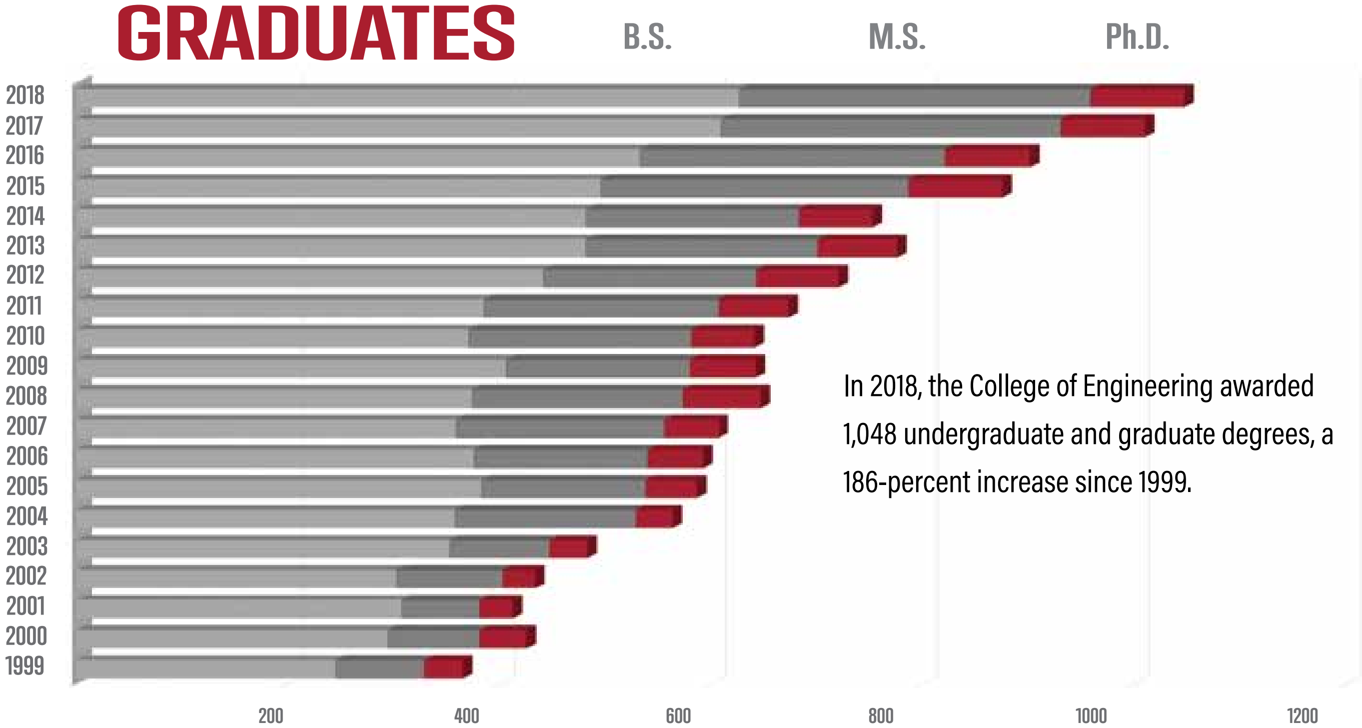
The University of Utah's College of Engineering continues to grow its number of faculty to meet the challenge of its rising student population. This year, the college has 192 tenure-track faculty members educating the next generation of engineers while also conducting world-class research.

RESEARCH EXPENDITURES



The College of Engineering is known for its innovative research across all disciplines, from biomedical devices to robotics and renewable energy resources. This year, its investment in exploring new technological ideas continues to rise with $82 million in research expenditures, a 228-percent increase from 2002.

GRADUATES



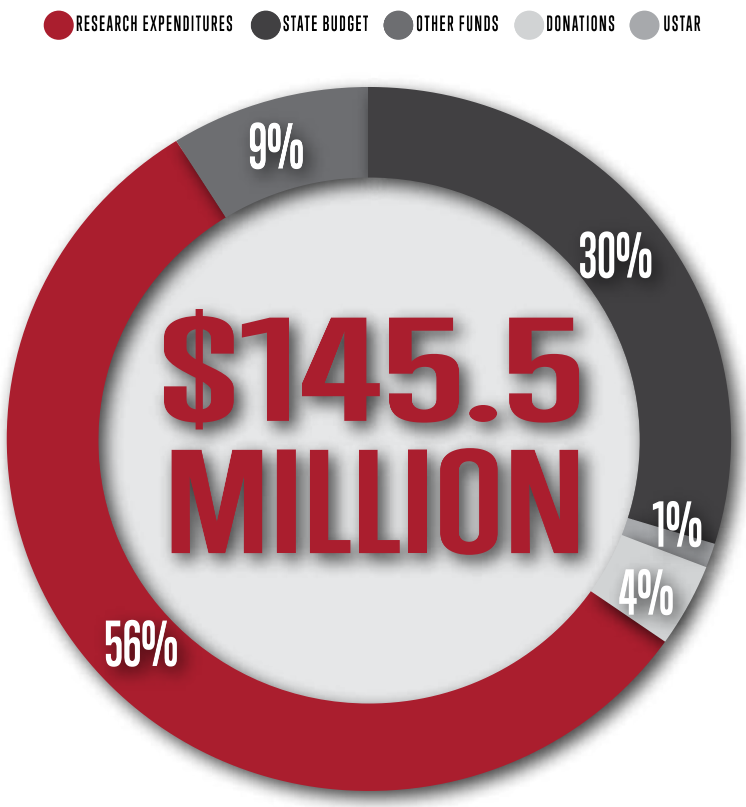
In 2018, the College of Engineering awarded 1,048 undergraduate and graduate degrees, a 186-percent increase since 1999.

RANKINGS

The University of Utah's College of Engineering is highly ranked in a number of areas, according to the 2017 U.S. rankings from Profiles of Engineering & Engineering Technology by the American Society for Engineering Education.

- Research expenditures — #36 (out of 279 schools)
- Engineering doctoral degrees awarded — #40 (out of 215 schools)
- Doctoral enrollment — #38 (out of 215 schools)
- Tenured/tenure-track faculty members (#29 out of 332 schools)
- Computer science doctoral degrees awarded (#14 out of 110 schools)

BUDGET 2016-2017



In 2017, the University of Utah was named in the Milken Institute's Best Universities for Technology Transfer as the top university in the nation for commercializing technology innovations. Turning ideas into marketable solutions is a priority for the College of Engineering. Since 2010, the college's faculty filed 521 invention disclosures while 61 licenses were executed. Faculty and students have launched 74 startups since 2006.

ENGINEERING THOUGHT LEADERS Q&A

ANNE TAYLOR

Vice Chair and Managing Partner, Deloitte (retired)

JOHN LALONDE

Chief Technology Officer, Abstrax Inc.

KEN MUIR

VP and GM Analytics, Operations & Security — IM&G, Micro Focus

With its tradition of innovation and entrepreneurship, the University of Utah's College of Engineering has produced generations of extraordinary graduates who have gone on to change the world through their own ground-breaking achievements. Among our most distinguished alumni are members of the Engineering National Advisory Council (ENAC) who volunteer their time and expertise to advise the dean and faculty leaders while serving as advocates for engineering excellence. Through their close association with the college, generous support, and active engagement, ENAC members have been helping to transform the college since the board was established in 2001. We asked these thought leaders to share their perspectives on the college's mission and progress.

As an ENAC member, you have been instrumental in helping Dean Brown to develop a strategic vision for the future. Considering our progress, what accomplishments are you most proud of?

Taylor: I'm impressed with how Dean Brown and his team have executed, improving the quality of faculty and students and continuing to improve the reputation of the College of Engineering as a premier research university. This can continue to be a virtuous cycle to drive growth, with rankings drawing even more talent.

LaLonde: To be able to triple the number of graduates while improving in the overall rankings, especially the rankings that ignore size and consider peer-reviewed articles, research expenditures and the like.

Muir: It's all about expansion and increasing both the quantity of graduating engineers and the quality of the education they receive. It's relatively easy to increase the numbers of engineers or increase the quality of education. It's a much larger feat to do both at the same time. The impact on the Utah economy has been tremendous.

What qualities differentiate the College of Engineering from its peers?

Taylor: Over the last several years, the College of Engineering has been re-defining its peer group. We shouldn't limit our view of competition or opportunity to within the PAC-12 or Utah. Within the PAC-12, the college provides a very high return on value for the student – both financially and in terms of hands-on experience. In Utah, the College of Engineering is unmatched for providing all the academic, employment and intellectual opportunity associated with a top research institution.

LaLonde: Being a very strong research institution, we teach a combination of theory and hands-on application of the theory which creates both a work ethic and understanding that prepare our students to hit the ground running. Pair that with our entrepreneurial attitude and energy — what better environment could a student have to prepare for success?

Muir: What sets us apart is the value of the education received at a relatively low price all while living in the best state in the country and working with faculty and an administration that deeply care about their students.

What do you see as potential challenges to future growth?

Taylor: One challenge to growth is the need to diversify both the student base and the employers hiring our students. The College of Engineering needs to attract more well-prepared women and out-of-state applicants. It will also be important to focus on branding. We want to be great everywhere but need to present the college in a way that differentiates it from others by focusing on our areas of strength.

LaLonde: The recent introduction of new and often scaled down engineering programs in institutions around the state will create more competition for precious state resources and runs the risk of weakening the academic quality of the programs and consequently the education of their students. To continue to prosper, Utah clearly needs a steady supply of technical graduates who have completed the academic rigor that characterizes engineering education at the state's research universities.

Muir: Balancing the demand with the ability to meet the demand. I'm not talking about the market demand for engineers. I'm referring to ensuring that we have young children/teens that are prepared and want to become engineers at a young age and the balancing act that comes with making sure we can handle it — if we invest/grow faster than the available students, or the inverse in which there are too many students and not enough funds.

As an alumnus of the college, which of your professors had the most impact on your development as an engineering and business professional?

Taylor: Dr. Robert Siegel impacted my professional career — and life — likely far beyond what he could've imagined. He opened my eyes to opportunities outside of Utah, suggesting I apply to a Ph.D program at Princeton. Later, he recommended me to an engineering firm that led to my over 30-year consulting career with Deloitte. Having a sponsor can be critical to any young professional, but as a woman I now realize how important his network and willingness to support me were.

LaLonde: This is very tough because they were all exceptional. I guess I would have to say Dr. Elliott Organick because he laid the foundation and oriented my thinking in a way that made everything that followed make sense.

Muir: The professor who both challenged and intimidated me the most was Dr. Magdy Iskander. About a week into my electromagnetics class, he threw his chalk against the board, told us to shut our books and that for the next two weeks "we were going to learn calculus!" He knew our math wasn't where it should have been. He cared. He spent the time teaching what we needed to know so that he could teach us what he was there to teach. Additionally, Joe Zachary and Carl Durney were outstanding professors who also showed me the importance of truly caring.

ENAC

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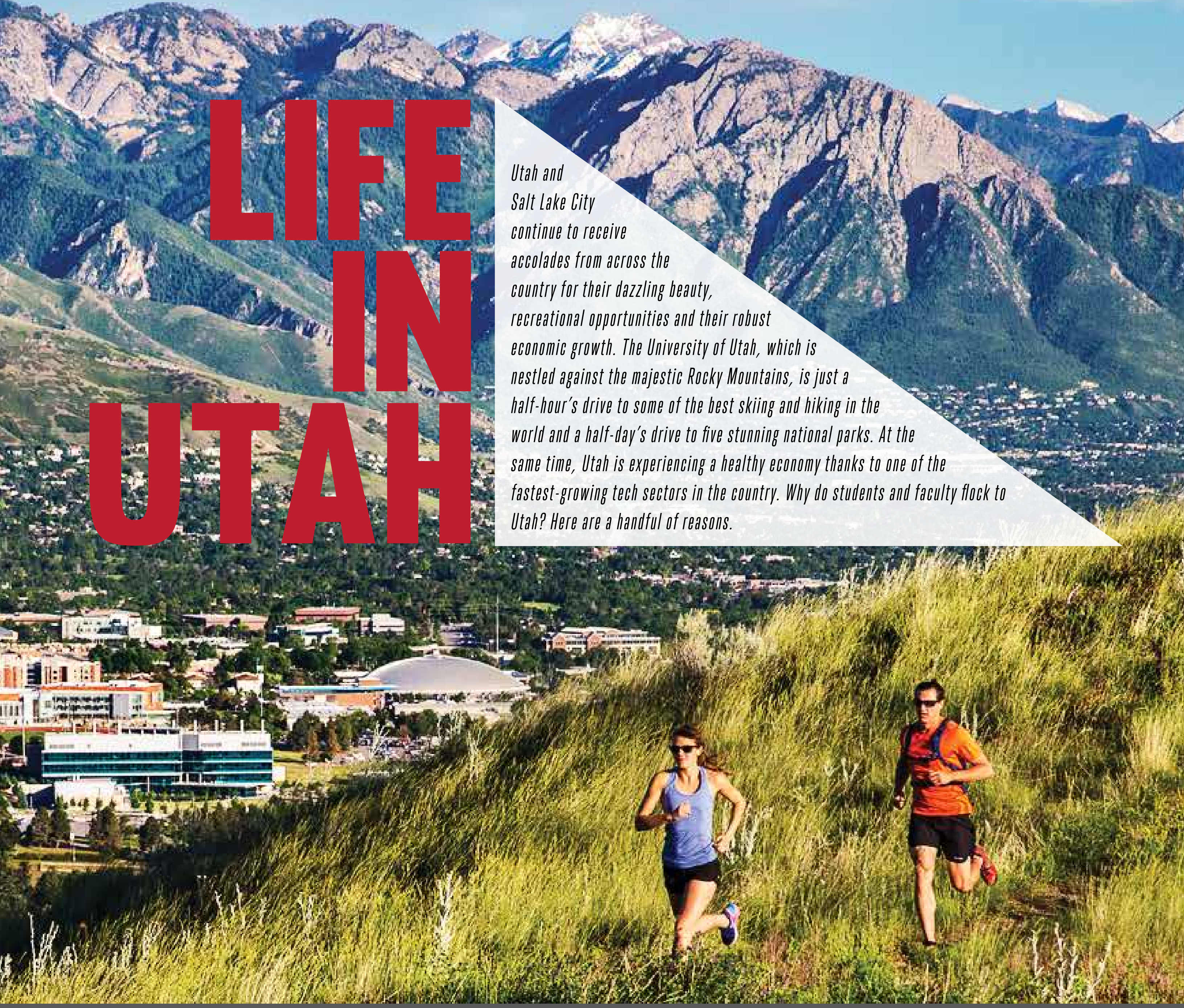


LIFE IN UTAH

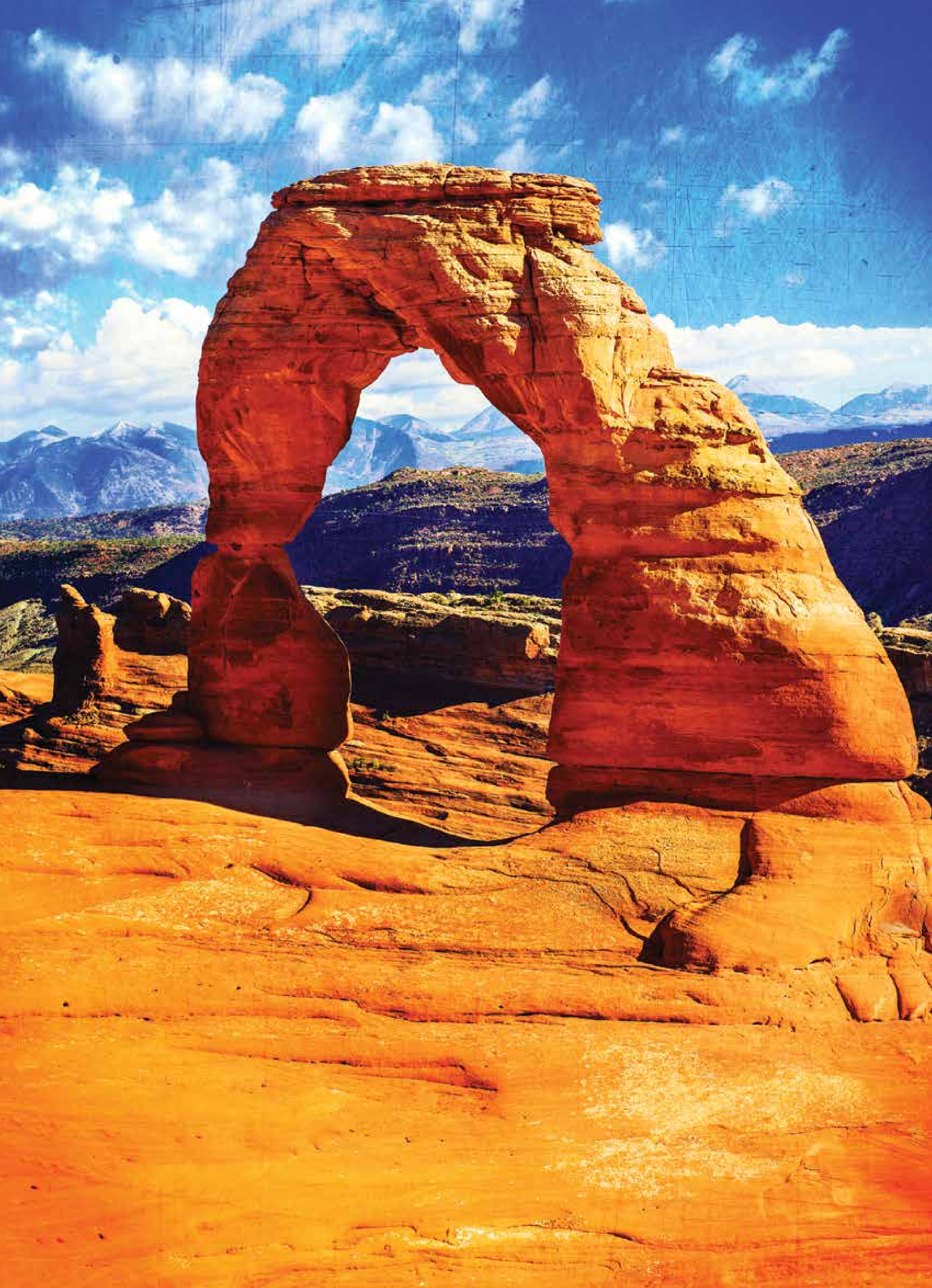
Utah and Salt Lake City continue to receive accolades from across the country for their dazzling beauty, recreational opportunities and their robust economic growth. The University of Utah, which is nestled against the majestic Rocky Mountains, is just a half-hour's drive to some of the best skiing and hiking in the world and a half-day's drive to five stunning national parks. At the same time, Utah is experiencing a healthy economy thanks to one of the fastest-growing tech sectors in the country. Why do students and faculty flock to Utah? Here are a handful of reasons.

UTAH

#1 Economic Outlook Ranking — American Legislative Exchange Council
#1 Best State for Employment — U.S. News & World Report
#1 The Best Colleges for Skiers in the Mountain West (University of Utah) — Powder
#1 Best Mountain Towns in America (Park City) — Men's Journal
#2 Best State to Start a Business — WalletHub
#2 Best States for Colleges — U.S. News & World Report
#2 Best Ski Destinations in the USA (Park City) — U.S. News & World Report
#3 Best States — U.S. News & World Report
#3 Best State in America — MarketWatch
#3 Best States for Business — Forbes
#4 Best Hikes in America (Zion National Park) — Travel + Leisure

SALT LAKE CITY

#1 Best Cities to Start a Career — WalletHub
#1 Cities with Amazing Job Opportunities Right Now — CNBC
#1 Best Place to Start a Career — CNBC
#3 Cities Where Employees are Happiest — Forbes
#3 America's Best Cities for Young Professionals — Forbes
#6 Top Housing Markets — Realtor.com
#15 Best Places to Live in the U.S. — U.S. News & World Report
#18 Best U.S. Cities for Finding a Job — Business Insider



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