THE UNIVERSITY OF UTAH
COLLEGE OF ENGINEERING

RESEARCH REPORT 2014

THE UNIVERSITY OF UTAH

FROM THE DEAN

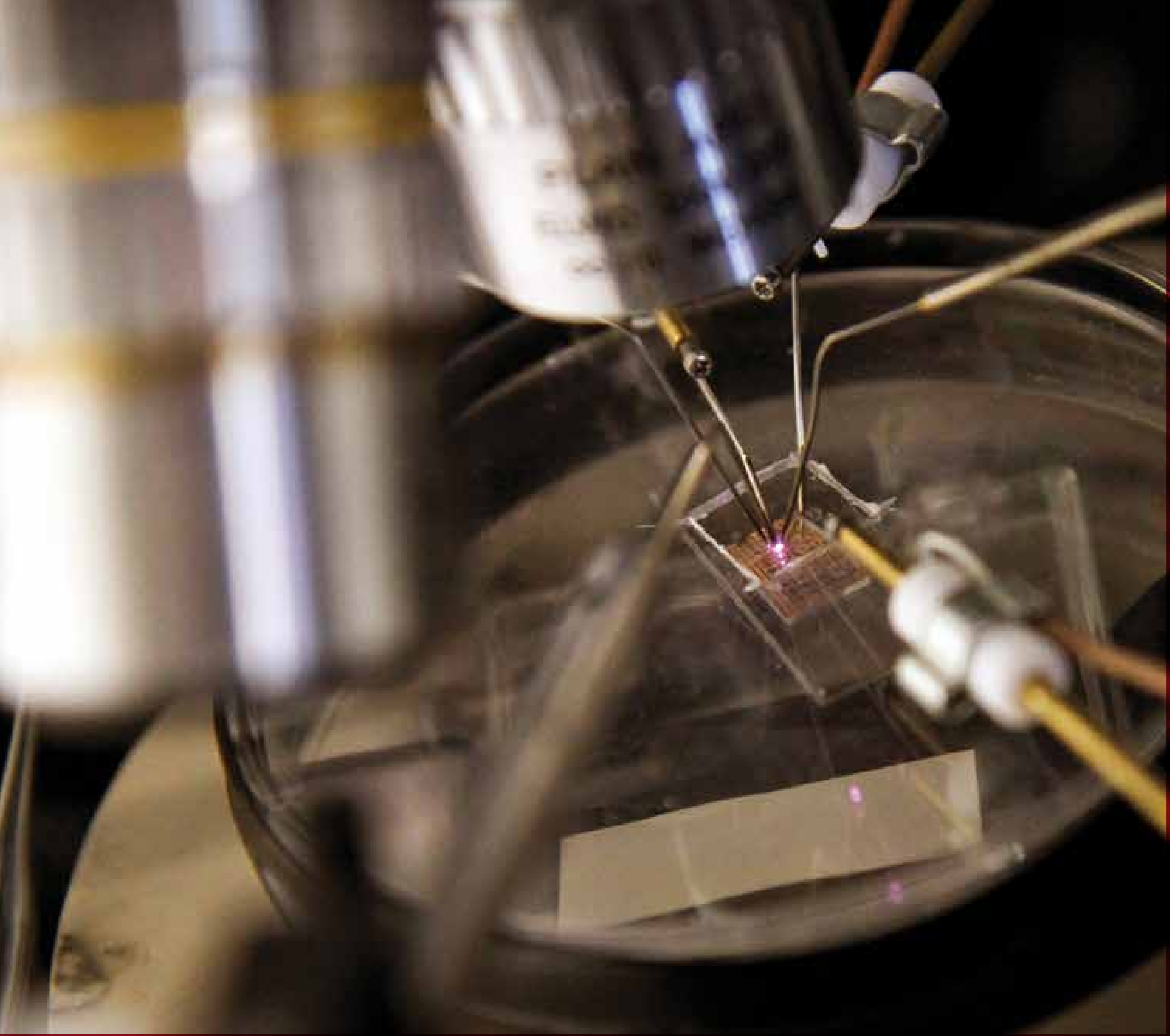
According to the latest ASEE's *Profiles*, the University of Utah College of Engineering ranks 33 out of 199 schools in the number of PhD degrees awarded. We are very pleased that the number of doctoral degrees granted per year at the U has more than doubled in the past 10 years.

As Utah's flagship engineering institution, the University of Utah is known for graduating the premier engineers and computer scientists in the state. That happens when bright students engage with world-class faculty at the leading edge of scientific exploration. The excitement of being in the lab and the experience of inventing something that pushes technological limits, adds depth to the educational experience and produces extraordinary graduates.

At our research-intensive university, the number and quality of graduate students is directly linked to the success of the college's approximately $80 million/year research activity and to attracting and retaining top faculty.

In the following pages, you will meet just a few of the faculty who are helping to mold and inspire the next generation of innovators. I hope you will be inspired by the creativity and passion that these featured faculty bring to the problems of renewable energy, big data, personalized medicine, and urban traffic design.

Richard B. Brown
DEAN, COLLEGE OF ENGINEERING



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ENGINEERING METABOLIC MACHINERY

Shelley Minteer / *Materials Science & Engineering*

Energy production is critical to our nation's economic stability, but the challenges of energy storage are often overlooked. An ideal storage solution would provide a convenient, readily accessible supply of energy while managing peak demand, allowing for improvements to the grid, and integrating renewable energy sources.

A battery, which converts stored chemical energy into electricity, is the most logical energy storage device currently available. In its three typical forms, a battery can be disposable, rechargeable, or serve as a fuel cell, which uses fuel and air to generate a chemical reaction. Today, fuel cells are used for power generation in remote areas from rural communities to deep space, as well as for electric vehicles.

Most fuel cells require precious metals such as platinum to kick-start a chemical reaction. These fuels operate reasonably well, but are not nearly as efficient as biological energy conversion, which breaks carbon bonds to trigger chemical reactions. For example, biological energy is generated when our bodies dismantle carbohydrates, sugars, proteins and fats from food using metabolic machinery encoded in enzymes.

"Most energy conversion devices out there have a lot of inefficiencies, but biological systems are very efficient," said Shelley Minteer, a Utah Science Technology and Research (USTAR) professor of materials science and engineering and of chemistry at the University of Utah. "We know plants can take sunlight and produce fuels, so we're interested in what we can learn from nature and biology to make an inefficient traditional system more efficient."

Minteer and her team of materials scientists, chemists and engineers explore how biological systems such as plants convert light or other energy into fuels. Supported by the Army Research Office, the Air Force Office of Scientific Research, and the National Science Foundation, the group unravels how metabolism occurs within plants and other living organisms, with the aim of unlocking the promise of relatively inexpensive components for fuel cells and other batteries.

"We've been translating that metabolism onto an electrode to make a biofuel cell with biocatalysts to break the carbon bonds in complex fuels," said Minteer. "Ideally, you want a material where you can place a biological entity on it and they can co-exist and electronically communicate with each other. These entities don't often behave the same way as they did before they were on the surface of another material. So we look at ways we can engineer a better interface."

Although energy conversion plays a significant role in metabolism, these processes use molecular machinery to conduct a wide range of tasks including cellular growth and elimination of waste. This makes pinpointing energy conversion a tricky endeavor.

"As we went along, we realized there are fundamental questions we need to address of how metabolism and photosynthesis occur before we can think about engineering new devices," said Minteer.

Minteer says her original view of mitochondria, which contain enzymes responsible for energy production, was "a Ziploc baggie full of catalysts." Her team discovered this wasn't the case—rather, mitochondria contain a nanostructured network of biological molecules between each catalyst that channels fuel from one catalyst to the next. This finding could help create engineered biological catalysts for fuel cells.

"Our group has been successful at taking biological catalysts and getting them to work together for artificial metabolism," said Minteer. "Now, we can apply the same principles we used for multiple biological catalysts to put different types of catalysts together. We're seeking genetic ways to get metabolism to happen more efficiently than it normally does."

SAFETY BY DESIGN

Although the annual number of fatal car crashes in the United States has generally decreased in the last decade, traffic-related accidents are still responsible for tens of thousands of deaths each year. With autonomous vehicles such as the Google self-driving car springing up on highways around the country, safety considerations and potentially significant safety improvements loom large for drivers, legislators and technocrats alike.

"The number one cause of death from the time you are age four to age 34 is a traffic-related accident, but only more recently have we begun to turn the study of road safety into a science, trying to quantify and predict where crashes are going to occur, how crashes occur, and what we might do to prevent them beforehand," said R.J. Porter, assistant professor of civil and environmental engineering at the University of Utah. "As autonomous cars become more common, there is going to be a very interesting transition period from a safety perspective—what's going to happen when we have this mixture of autonomous and traditional vehicles on the road? How and where on the road will we transition from vehicle control to driver control?"

These and other road safety questions are a core focus of Porter's research group at the U. Porter is also director of the Utah Traffic Laboratory at the University of Utah, which has access to 24-hour traffic cameras throughout the state. This floor-to-ceiling video display is a scaled-down version of the traffic control center at the Utah Department of Transportation. The Utah Traffic Laboratory informs Porter's research on the design, operations, reliability and safety of road infrastructure for different types of users including automobiles, mass transit, bicyclists and pedestrians.

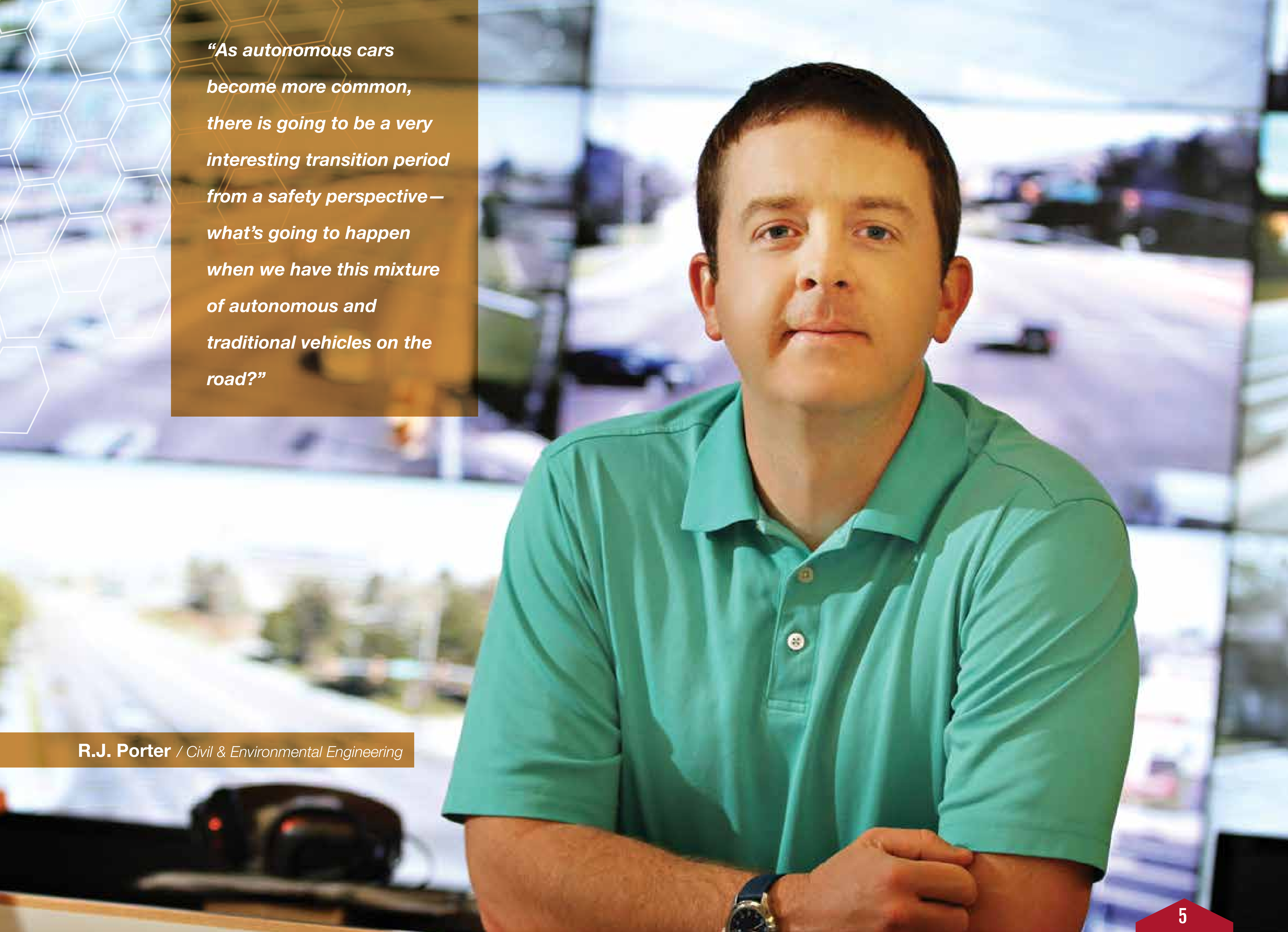
"With tighter and tighter budgets for infrastructure projects but more infrastructure needs, the government says if you are going to use federal dollars, we want to see a very systematic and detailed approach to what you are going to invest in," said Porter. "These conditions are pushing the need for performance-based transportation planning, project selection, and design, and involves looking at the context of the project, recognizing what is needed at that location, and designing to achieve some desired level of performance for different road users."

Porter and his research group are trying to quantify the outcomes of various traffic infrastructure projects in Utah to understand how these projects impact access to transportation and quality of the transportation experience. In particular, says Porter, there is a lack of information on the efficiency and reliability of movement.

"We want to consider how easy it is for people to get from unique origins to their destinations, and how consistently they can get from point A to point B," said Porter. "For example, if you have a 30-minute drive to work in Salt Lake City, you need to provide yourself about 40 minutes each day if you only want to be late for work once a week. For this same trip in Washington D.C., you would need to provide yourself about 77 minutes each day if you only wanted to be late once a week."

With support from the U.S. Department of Transportation, the Transportation Research Board, the Utah Transit Authority, and the Utah Department of Transportation, Porter says he wants to continue making the most efficient use of taxpayer money for the future of transportation.

"Our projects, each one, should provide the biggest benefit to the public possible, keeping economy, safety, mobility and quality of life in mind," said Porter. "We need tools to help understand how the transportation investment choices we make impact people's decisions in our local area, region, state and country."



“As autonomous cars become more common, there is going to be a very interesting transition period from a safety perspective—what’s going to happen when we have this mixture of autonomous and traditional vehicles on the road?”

R.J. Porter / *Civil & Environmental Engineering*

DECONSTRUCTING BIG DATA

Jeff Phillips / *School of Computing*

As the role of technology in our lives continues to grow, the data we generate are increasingly scattered across many channels. Networks of computers and the cloud store our work documents, music and photos, while social media are increasingly used to communicate in real time as major events unfold.

Big data affects everything from analyzing traffic patterns to managing sensitive information online. This burgeoning field addresses data too large, fluctuating and complex to tackle with standard computational methods or tools. Although use of big data is a national trend, the skills needed to manage big data are especially critical in Utah, where companies such as Adobe, eBay and Goldman Sachs, as well as the National Security Agency, store and process vast reserves of data.

As a graduate student, Jeff Phillips was analyzing data from anonymous patients at a hospital with a specific disease. Based on patient addresses, Phillips wanted to find spatial regions where this disease was more prevalent.

“This led to me thinking about the statistical nature of data, and I realized a lot of data could be converted to a high-dimensional space with a lot of geometric structure,” said Phillips, who is now an assistant professor of computer science at the University of Utah. “Since then, I’ve been inspired by new data sets, largely from internet companies. It’s easy for companies to collect this information, but processing and analyzing large stores of data is at the point where the traditional analytical tools are breaking down.”

With his research group and support from the National Science Foundation, Phillips is extending techniques such as principal component analysis to very large data sets. This technique uses matrices, which contain data distributed across myriad rows and columns, to study large data sets. For example, each row in a matrix could represent a customer, while each column is an attribute or feature about this customer, such as the number of clicks on a webpage or purchase of a product.

“What you end up with is a linear combination of all of your features in one dimension, like taking all your customers and drawing them on a single line. This tells you the most important features,” said Phillips. “On one side, you may have people that spend a lot of time online that buy a lot of products. On the other side are people who don’t buy a lot and don’t spend much time online.”

Another technique, called a kernel density estimate, address errors in large volumes of data. Here, millions of data points and their corresponding error are “smoothed” to create a bump, or kernel, that converts unwieldy amounts of data into a simpler representation. This strategy could help medical technicians, businesses and other organizations sift through data more quickly, adds Phillips.

Phillips is also director of a new graduate program in big data, which addresses large sets of data too complex, diverse or rapidly changing for one computer to handle. The certificate program, which begins this fall, capitalizes on the University of Utah’s strengths in computer science and big-data processing. It will provide students and professional computer scientists with courses in data mining, machine learning, database systems, visualization and advanced algorithms.

These courses, already taught through the U’s School of Computing, will now include options for distance education such as online video, internet-video office hours and classes late in the day. The program also will include training on ethical issues associated with data management and analysis.

“We want our graduates to understand history and where the field is going, so as new challenges surface, they can continue to learn and contribute,” said Phillips. “This is probably the most important skill to have, to be able to keep up with new developments as they progress, rather than learning a trade and applying this skill for the rest of your career. In technology, the trade is building on new approaches that arise.”

NSF CAREER AWARDS

The College of Engineering is pleased to recognize five outstanding young faculty who have received NSF CAREER awards between July 1, 2013 and June 30, 2014.

Mathieu Francoeur, Department of Mechanical Engineering
Francoeur's award will allow his group to demonstrate that power generation in a nanoscale-gap thermophotovoltaic device can be enhanced by a factor of 20 to 30, compared to conventional thermophotovoltaic systems, due to radiation heat transfer exceeding the blackbody limit. About 58 percent of the energy consumed annually in the United States is lost to heat. Francoeur says this project is an important step toward the development of miniature waste heat recovery devices that could be used in personal computers and cell phones.

Matthew Might, School of Computing
Software engineers are uniquely disadvantaged among traditional engineering disciplines because they lack a viable predictive model for the systems they design and build. Might's award will support critical foundations for the science of software prediction and will significantly strengthen the foundation of national cyberinfrastructure. The development of a systematic method will guide synthesis of static analyzers for complex, modern programming languages. The systematic transformation of small-step interpreters into static analyzers promise more opportunities for optimizing speed and precision and clearer analyses of results.

Berardi Sensale-Rodriguez,
Department of Electrical and Computer Engineering
Sensale-Rodriguez's award will support research and development of terahertz (THz) devices for low-cost communications and imaging systems. The increasing use of wireless communications for data-dense media and services is overtaxing existing infra-

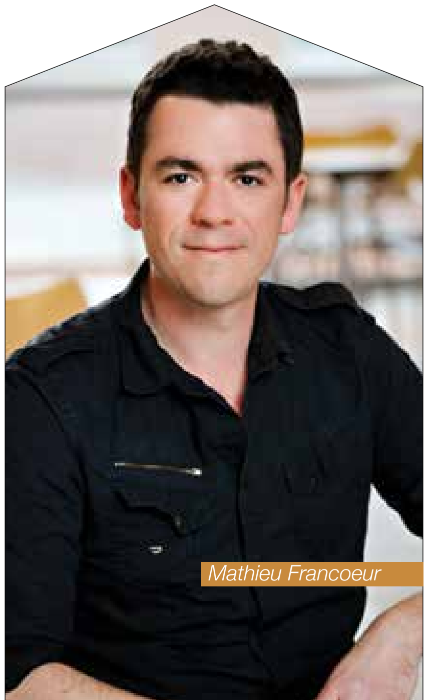
structures. New THz-based solutions could permit larger bandwidths than the radio frequency and infrared wavelengths currently supporting wireless communication. Beyond wireless communications, THz technology could spur advancement of medical devices such as skin cancer detection imaging systems. To make these devices cost-effective, his program will focus on employing thin-film semiconductors.

Alan (Chuck) Dorval, Bioengineering

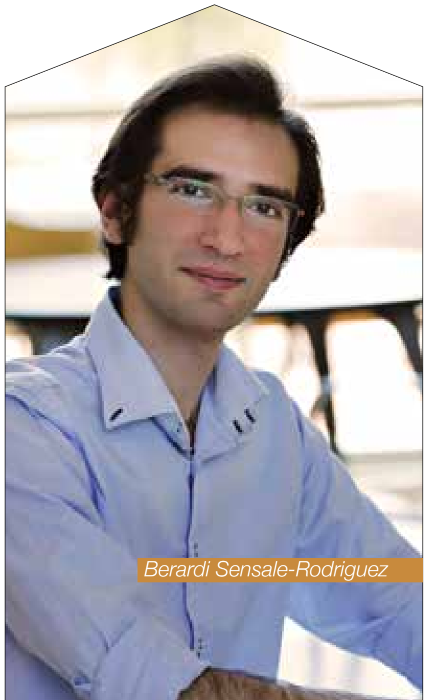
The overall goal of this project is to teach the brain how to converse with computational systems. Dorval's award will support teaching neural tissue to manage a brain-computer interface to control external devices, such as a motorized wheel chair or a robotic arm. If neurons in a small area could be taught to generate a coordinated signal, wearable devices could use those robust signals to reliably control external devices. This research will eventually enable long-term, reliable, and robust, brain-computer interfaces for neural rehabilitation of people with disabilities.

Jeff Phillips, School of Computing

Data is becoming a central currency of modern science, and an important role of computational geometry is to understand and formalize the structure of data. However, much of classical computational geometry inherently assumes that all aspects of data are known and precise. This is rarely the case in practice. Phillip's award will support building the foundations for two extensions to classic geometric settings pertinent to noisy data: 1) formalizing how to construct, approximate, and concisely represent this uncertain data, and 2) smoothing data, removing degeneracies, and implicitly simplifying and regularizing algorithms.


Mathieu Francoeur

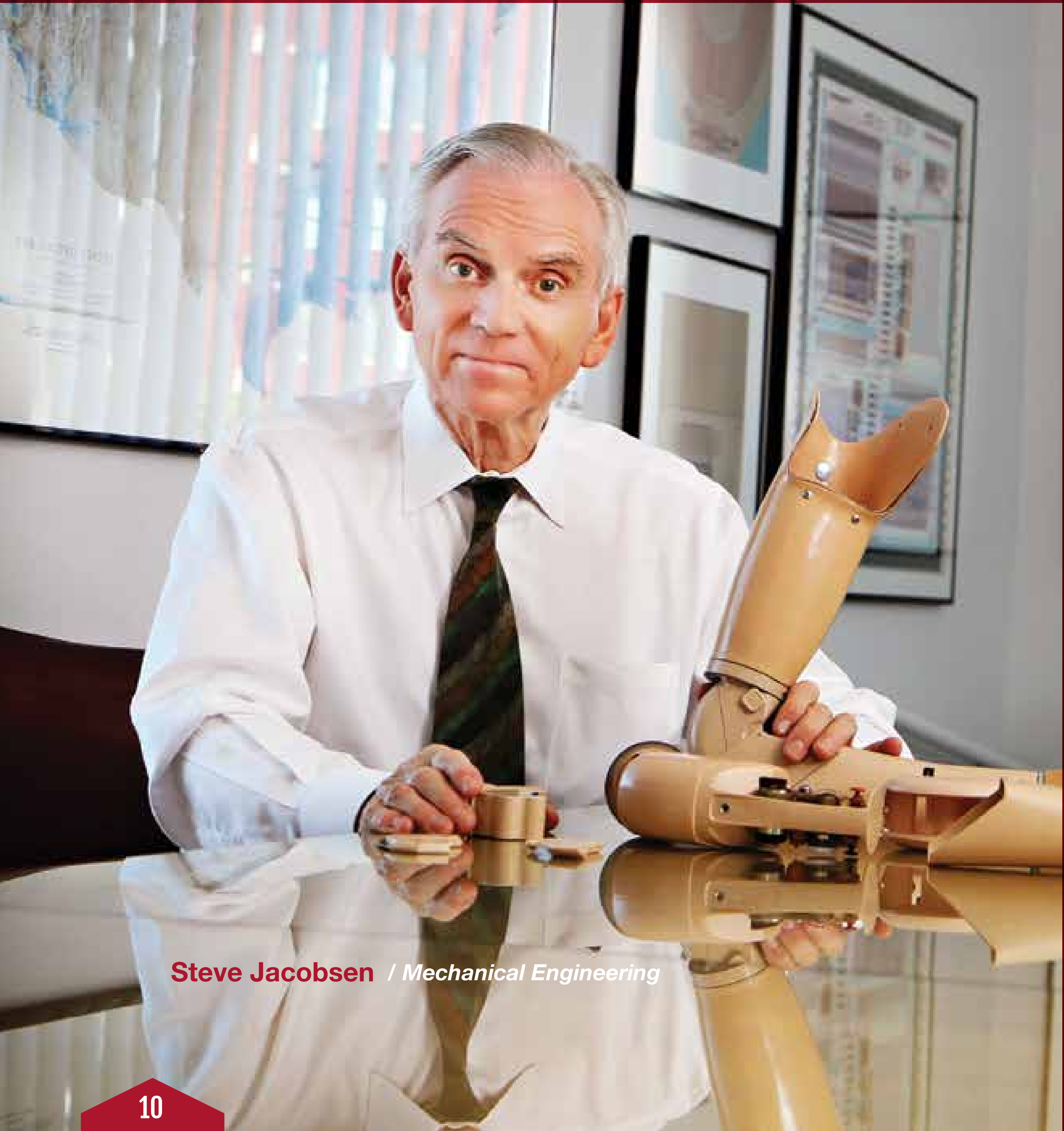

Matthew Might


Berardi Sensale-Rodriguez


Chuck Dorval


Jeff Phillips

TAPROOT OF INNOVATION



Steve Jacobsen / ***Mechanical Engineering***

University of Utah College of Engineering faculty and students are lauded for their efforts to commercialize intellectual property through invention disclosures and patents. Indeed, the University of Utah is consistently near the top of the Association of University Technology Mangers' rankings for launching startup companies from university research.

However, the drive to commercialize university research wasn't always a widely accepted model of success. In the early 1970s, Stephen Jacobsen, distinguished professor of mechanical engineering at the University of Utah, worked with like-minded faculty and students from other departments on campus, other academic partners, and companies to embark on research and development projects that "were grounded in engineering, medical, and scientific principles, but also generated results that can be used by people in the form of products," said Jacobsen.

During the next 25 years, Jacobsen, his colleagues, and other similar laboratories developed many new systems and products for national laboratories and for more than 200 governmental organizations and commercial clients worldwide.

Jacobsen considers himself fortunate to have worked for artificial organ innovator Dr. Willem Kolff in the mid-1960s. Along with Dr. Robert Stephen and researchers from U Health Sciences, they developed the first wearable artificial kidney that allowed portable dialysis for patients, and later, with Dr. Carl Kablitz, the first reciprocating peritoneal dialysis system.

During former engineering dean Wayne Brown's tenure, Jacobsen launched the Center for Engineering Design with bioengineer John Wood. The U, along with similar centers at Carnegie Mellon University and the Massachusetts Institute of Technology, were tasked by the National Science Foundation to better understand how to convert high technology developments into successful commercial products.

In 1973, based on Jacobsen's doctoral work at MIT, he and colleagues such as electrical engineer Todd Johnson and mechanical engineer David Knutti designed the Utah Artificial Arm. This prosthetic, controlled by myoelectric sensors and electric actuators, translated electrical pulses from muscles into arm movement. Jacobsen spun off the intellectual property into Motion Control, Inc., led by U bioengineering graduate Harold Sears. The Utah Artificial Arm has been used by thousands of arm amputees since its introduction.

This artificial arm breakthrough led to a revolution in robotics. Jacobsen initiated the development of linear scale sensors and other microscale devices, and coined the term used for these devices—microelectromechanical systems, or MEMS. In 1987, as the number of commercial projects grew, Jacobsen formed Sarcos, Inc.

"Each concept that is designed is based on a story that evolved from a group of designers. Designers are great storytellers," said Jacobsen. "I call it narrative-based design with forced epiphanies."

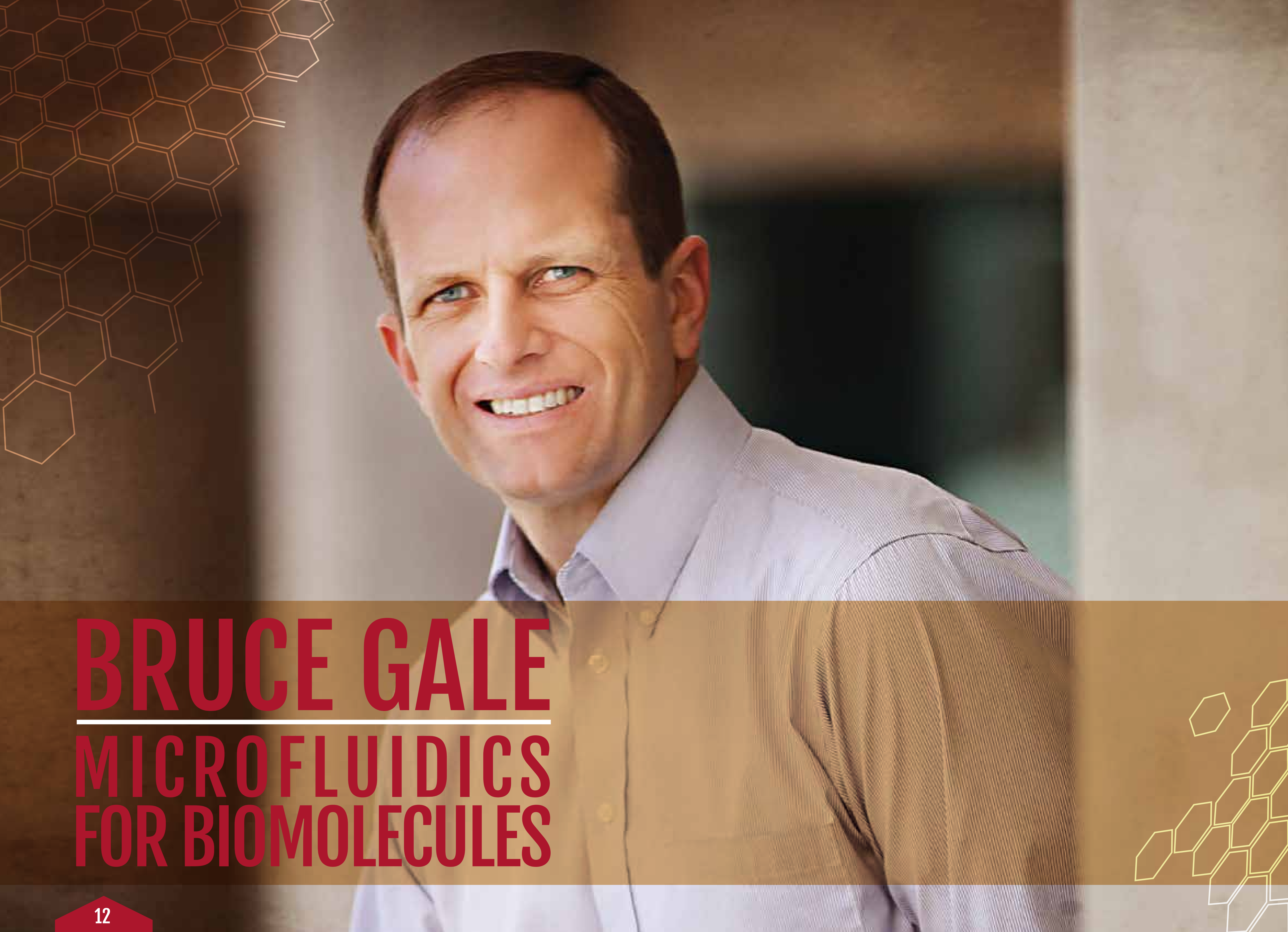
Jacobsen and Sarcos engineering and production colleagues including Mike Mladjovsky, Dave Marceau, Wayco Scroggin, Glen Colvin, Chris Maggio, John McCullough completed hundreds of projects ranging from microjet drug delivery pumps (with U bioengineer Tomasz Petelenz) to powered exoskeletons and unmanned ground vehicles for the military and wearable physiologic status sensors that allowed commanders to know where soldiers were on the battle field and their physical status.

Sarcos also pursued entertainment projects, including 100 robots for the Euro-Disney Company's sword-wielding pirates for the Pirates of the Caribbean ride, 80,000-pound full-size dinosaur robots for Universal Studios, and robotic fountains in conjunction with Mark Fuller and his company WET Design for the Bellagio Las Vegas.

All told, Sarcos had more than 100 clients, including Merck, Baxter, Pfizer, Ford Motor Company, Boeing and Honda, along with government agency DARPA, Bell Laboratories, the United States military, and academic institutions. Sarcos generated five successful spin-off companies and more than 200 patents. In 2007, Raytheon purchased certain military assets of Sarcos.

Building on Jacobsen's foundation of innovation, the College of Engineering encourages research opportunities that translate technologies into the marketplace. The recently launched Center for Engineering Innovation helps researchers transform inventions into ready-to-produce devices, while the Technology and Venture Commercialization group works with campus faculty to commercialize new technologies and inventions from discoveries made and developed at the U. In fiscal year 2013, research from College of Engineering faculty generated 69 invention disclosures and 38 issued U.S. patents.

"Steve Jacobsen was a pioneer in the commercialization of university research at a time when only a few universities knew how to manage it, and many academics still thought it was inappropriate," said Richard Brown, dean of the College of Engineering. "Now, it seems like almost every school is trying to get into the game. I am delighted that the University of Utah, and especially the College of Engineering, have become known as national leaders in commercialization of university research."



BRUCE GALE

MICROFLUIDICS FOR BIOMOLECULES

Microfluidic devices were originally designed to address small volumes of fluids for inkjet printers or lab-on-a-chip technologies. Although this technology started in the 1980s, microfluidics has expanded to apply principles of fluid flow to problems in biochemistry, nanotechnology and biotechnology.

Today, microfluidics is one facet of the future of medicine. Personalized medicine will one day use detection of biomarkers to indicate the presence of diseases long before the appearance of symptoms. However, detecting these molecules still requires costly equipment and specialized technicians.

University of Utah mechanical engineering professor Bruce Gale and his research group have explored myriad applications for microfluidics since Gale joined the U in 2001 as an assistant professor. With students in engineering and collaborations in chemistry, medicine and beyond, Gale says the possibilities are endless.

“We’re having an exciting new conversation every week about how microfluidics could help with solving genetic questions, detecting bacteria, or finding new drugs for cancer treatment,” said Gale, who directs both the State of Utah Center of Excellence for Biomedical Microfluidics and the Utah Nanofab. “Because microfluidic devices are the same size as a lot of biological components, we can tackle a practical medical problem and simultaneously explore the science that lies underneath.”

One of these rewarding conversations connected Gale with Jay Agarwal, an associate professor of surgery in the Division of Plastic and Reconstructive Surgery at the University of Utah School of Medicine.

The two have struck up a successful partnership leveraging microfluidics for medical applications ranging from reconstruction of arteries to a mechanical leech that uses anti-coagulants to thin the blood and prevent clotting, much like a leech does through its saliva.

The mechanical leech concept led to a successful undergraduate senior capstone project for U engineering students Scott Ho, Jessica Kuhlman and Andy Thompson, whose efforts led to a bronze medal at the U.S. Collegiate Inventors Competition in late 2013.

Gale’s most recent endeavor with Agarwal involves nerve regeneration devices used to physically guide the regrowth of nerves. The number of

injuries resulting in severe nerve damage and amputation for wounded soldiers has increased in recent years, prompting researchers to explore routes to heal nerve damage.

“If you were to sever a nerve, the part that is connected to your brain is still alive and will direct the nerve to slowly regrow,” said Gale. “However, this regrowth will occur randomly, with branches everywhere like a tree.”

Gale and his team are developing a two-pronged approach to physically constrain the nerve regrowth in one direction, while using a microfluidic device that releases drugs at a steady rate to help speed up the regrowth process.

The microfluidic device consists of a narrow channel that releases the drugs steadily through diffusion. This method allows any drug to be loaded in this chamber and released. If the gap between new regrowth and the severed nerve isn't bridged in about 30 days, the rest of the nerve starts to die.

Using the team's device, the gap is expected to be bridged in 15 to 20 days. With the drugs delivered locally, Gale says nerves can grow up to a millimeter per day—50 percent faster than if these nerves were left to regenerate alone.

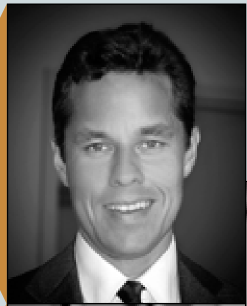
"Instead of having to reengineer this device for every different application, we have created a delivery device that is very generic," said Gale. "We're getting ready to put this into animal models during the next few months and will see how the nerve regeneration is different."

"Bruce and I have been collaborating for the past five years on a number of projects focused on improving the lives of civilian and military patients undergoing surgery for reconstruction after trauma or tumor extirpation," said Agarwal. "Our successes include the recent development and licensing of a novel vascular coupling device and the Department of Defense funding of our biodegradable drug-delivering nerve conduit for peripheral nerve repair operations and research. Our team approach, which includes some of the brightest students at the U, is what has made our collaboration so fruitful."

Along with his research accomplishments, supported by the National Institutes of Health and the National Science Foundation, Gale has also embraced the entrepreneurial spirit at the U. In 2005, he and some students launched Wasatch Microfluidics, to develop highly parallel microfluidic sensors to detect biological molecule binding. The latest version of their multiplexed sensor, which can perform many analyses at once, has 96 channels. The company currently has 12 employees and has raised $8 million in investment funds and grants.

"Whether it's on campus or through our company, we provide microfluidic designs for interesting problems with tools that can be made cheaply and practically to solve problems in a short time frame," said Gale. "The longer I've been here, the more people come talk to us. As these efforts continue to grow, we hope to impact many different fields."

NEW FACULTY



CHRIS BUTSON
Bioengineering, School of Computing
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LUTHER MCDONALD IV
Nuclear Engineering
Ph.D., analytical and radiochemistry, Washington State University
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Ph.D., theoretical and applied mechanics, Cornell University
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ASHLEY SPEAR
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FRANK SACHSE
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Privatdozent (state doctorate), biomedical engineering, Universität Karlsruhe, Germany
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WENDA TAN
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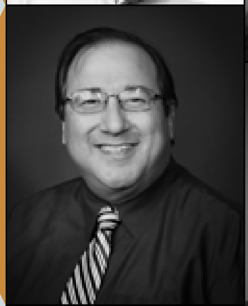
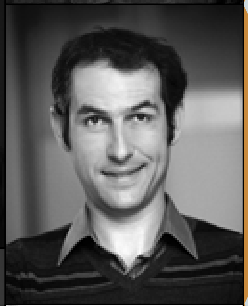
HARI SUNDAR
School of Computing
Ph.D., bioengineering, University of Pennsylvania
Computationally optimal high-performance, parallel algorithms



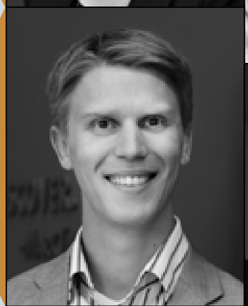
MICHAEL BARBER
Department Chair, Civil and Environmental Engineering
Ph.D., civil engineering, University of Texas, Austin
Water resources, water quality, impact of bioenergy on water demand



ROSS WALKER
Electrical and Computer Engineering
Ph.D., electrical engineering, Stanford University
Sensors, mixed signal integrated circuits and systems, applied signal processing and machine learning

XIAOYUE (CATHY) LIU
Civil and Environmental Engineering
Ph.D., transportation engineering, University of Washington
Traffic operations, large-scale transportation modeling and simulation, intelligent transportation systems

KEUNHAN (KAY) PARK
Mechanical Engineering
Ph.D., mechanical engineering, Georgia Institute of Technology
Nanoscale heat transfer, scanning probe thermal/optical microscopy, nanomanufacturing



MICHAEL HOEPFNER
Chemical Engineering
Ph.D., chemical engineering, University of Michigan
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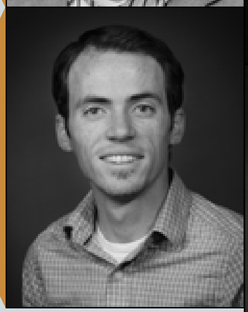
TARA DEANS
Bioengineering
Ph.D., biomedical engineering, Boston University
Synthetic biology, biomaterials, tissue engineering, cell therapies



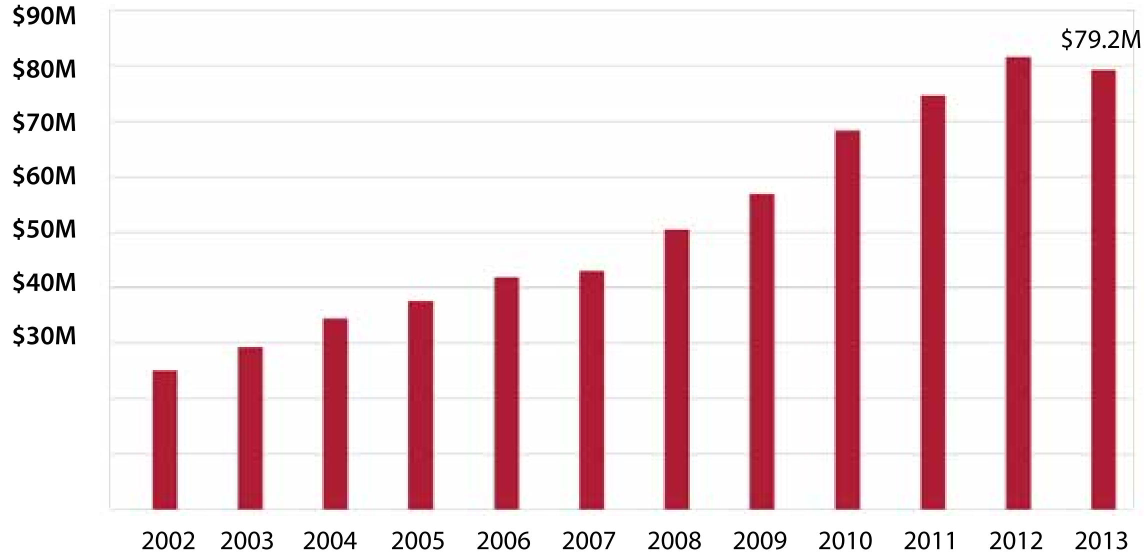
TAYLOR SPARKS
Materials Science and Engineering
Ph.D., applied physics, Harvard University
Thermoelectrics, energy materials, data mining, ceramics

MICHAEL (SEUNGJU) YU
Bioengineering
Ph.D., polymer science and engineering, University of Massachusetts at Amherst
Polymers, biomaterials, protein, peptide and tissue engineering, drug delivery

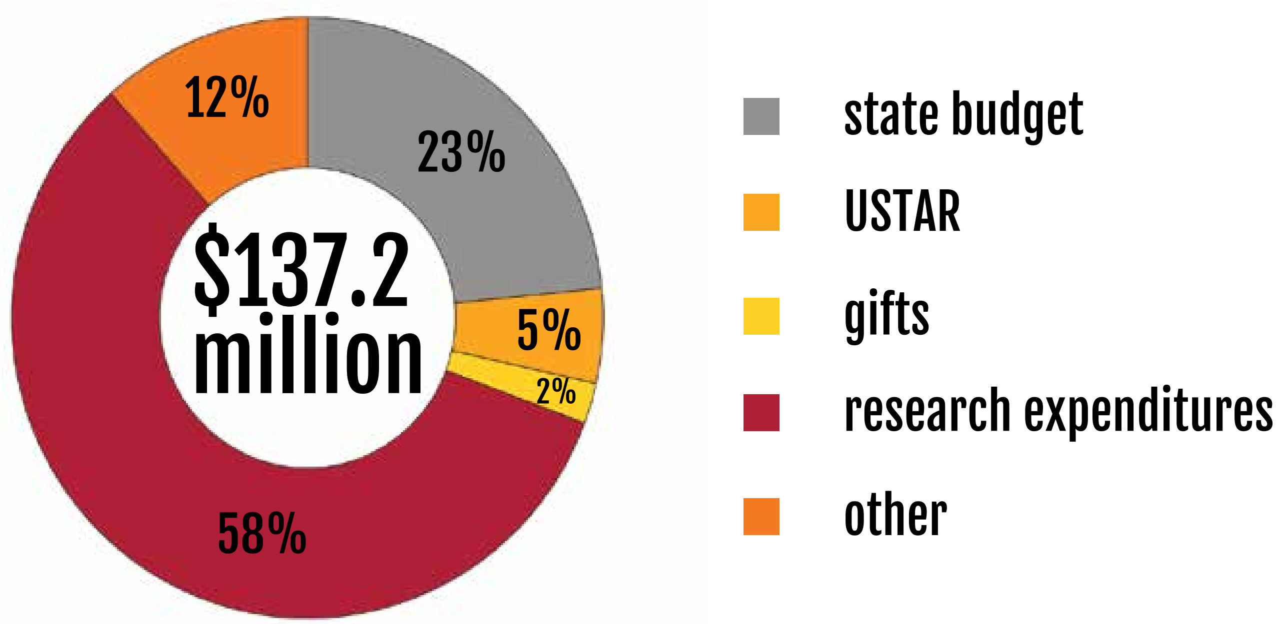
BY THE NUMBERS

RESEARCH EXPENDITURES

With $79.2 million in annual research funding, the University of Utah College of Engineering is #33 (of 208 total) in research expenditures by U.S. engineering schools* in 2013.



BUDGET 2012 – 2013



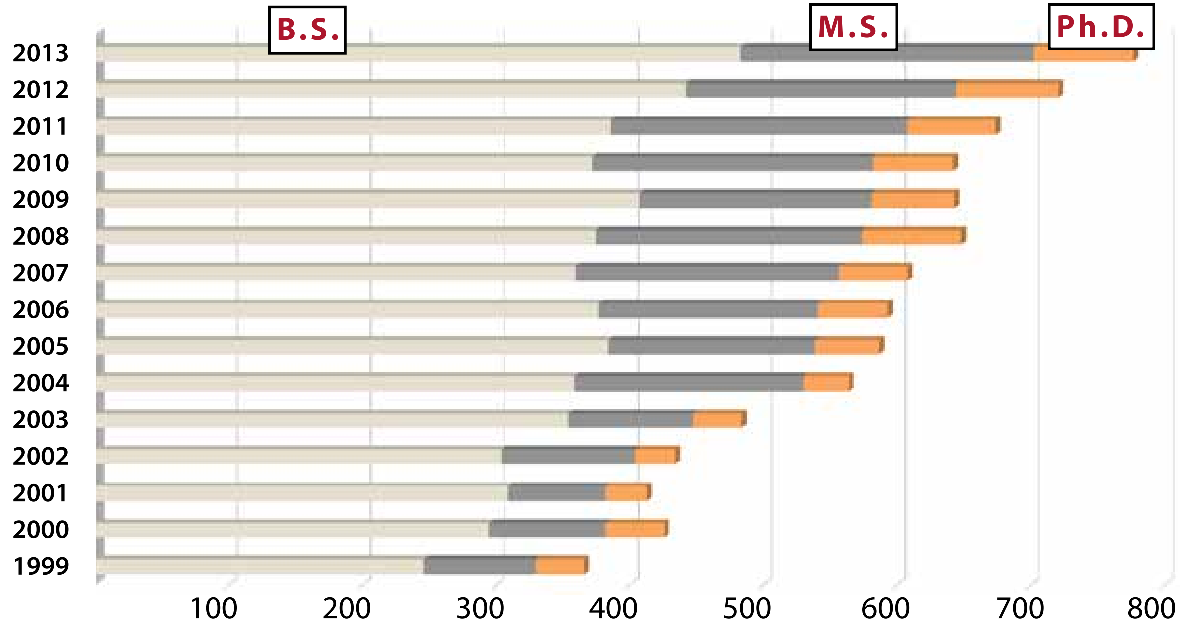
GRADUATES

The College continues to rank in the top 50 U.S. engineering colleges* in undergraduate degrees awarded by discipline and graduate degrees awarded:

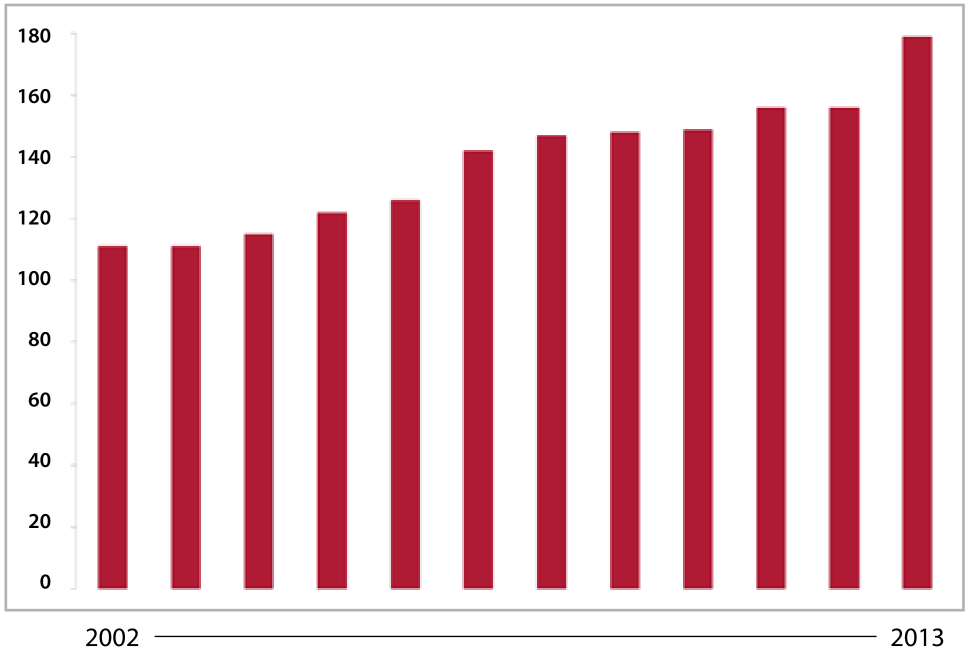
#23 in computer science (of 172 total)
#40 in electrical engineering (of 258 total)
#47 in mechanical engineering (of 289 total)
#33 in doctoral degrees (of 196 total)

The College ranks
#51 in undergraduate enrollment* (of 355 total)
#43 in graduate enrollment* (of 272 total)

*Statistics from *Profiles of Engineering and Engineering Technology Colleges,* American Society of Engineering Education (2014).



TENURE-TRACK FACULTY



The University of Utah College of Engineering has made remarkable strides in *U.S. News & World Report's* "America's Best Colleges" ranking of undergraduate programs. The College rose faster than any engineering college at a U.S. public university, from #70 in 2008 to #59 in 2014.

The College is #25 in the number of tenure-track faculty* (of 355 total) in 2013, and 19 new faculty members have joined the College in 2014 (see New Faculty, page 16-17).

For 2013, the College ranked in the top 100 engineering/technology and computer science programs in the Academic Ranking of World Universities. These prominent world university rankings weigh academic performance, international recognition and research expenditures:

#85 Academic Ranking of World Universities
#76 –100 Engineering and Computer Science
#51—75 Computer Science

DISCIPLINES

The University of Utah College of Engineering has seven departments and six specialty programs. Spanning diverse subjects from brain-computer interfaces and artificial organs to autonomous robots and ways to optimize oil and gas recovery, significant federal funding fuels 27 large, highly competitive, multi-investigator centers and institutes that involve College faculty.

Mechanical Engineering
This broad discipline spans expertise in design and manufacturing, biomechanics, dynamics and control, ergonomics, mechatronics, robotics, aerospace engineering, solid mechanics, thermal fluids and energy systems.

Electrical and Computer Engineering
Electrical and computer engineering traverses communications, image and signal processing, optoelectronics, microwaves and electromagnetics, device fabrication, control systems and power engineering.

Civil Engineering
Civil engineering underpins society's infrastructure, with expertise in geotechnical and construction materials, structural engineering, transportation, water resources, environmental engineering and engineering management.

Bioengineering
Bioengineering integrates engineering, biology and medicine for detection and treatment of human disease and disability. Research includes cell and tissue therapeutics, neural and cardiovascular engineering, biomedical imaging and bio-design.

Materials Science and Engineering
This discipline links physical and chemical properties of materials with their macroscale properties. Research expertise lies in nanomaterials, ceramics and composites, electronic materials, and computational methods for engineering applications.

Chemical Engineering
Chemical engineering spans diverse topics such as medical devices, combustion, energy, semiconductors, personal care products, minerals, petroleum refining, oil, water purification, natural gas pipelines and petrochemicals.

School of Computing
Coupling theory and practice in the study of computing, this department focuses on digital media, scientific computing and visualization, artificial intelligence and information management.

Entertainment Arts and Engineering Program
This highly ranked interdisciplinary program encompasses skills for the digital entertainment industry: video games, digital animation and computer-generated special effects, among others.

Utah Nuclear Engineering Program
This program emphasizes nuclear medicine, nuclear forensics, nuclear reactor modeling and detection, radiation shielding for space missions and computational techniques.

Petroleum Engineering Program
This program covers engineering and geology fundamentals and advanced topics in petroleum engineering, along with discussion of geopolitical, economic, and environmental constraints on energy technologies.

Computer Engineering Program
Offered by the Department of Electrical and Computer Engineering and the School of Computing, this program includes the design, implementation, and programming of digital computers and computer-controlled electronic systems.

Big Data Program
This program addresses the emerging field of big data: data too large, complex, and diverse for one computer to handle. Big data impacts everything from studying traffic patterns to managing sensitive information online.

Data Center Engineering Program
Drawing on existing coursework in mechanical engineering, electrical engineering and computer science, this program provides unique skills needed to enter the workforce in data center operations and management.

MULTIDISCIPLINARY RESEARCH CENTERS AND INSTITUTES

Scientific Computing and Imaging Institute

Institute for Clean and Secure Energy

Energy & Geoscience Institute

Nano Institute

Utah Nanofab

Cardiovascular Research and Training Institute

Huntsman Cancer Institute

NSF Materials Research Science and Engineering Center

Center for Engineering Innovation

Utah Center for Nanomedicine

Utah Center for NanoBioSensors

Utah Center for Nanomaterials

Utah Center for System Integration

Utah Center for Interfacial Sciences

Utah Center for Advanced Imaging Research

Utah Center of Trace Explosives Detection

Center for Neuroimage Analysis

Center for Parallel Computing

NIH Center for Integrative Biomedical Computing

Center for Controlled Chemical Delivery

Rocky Mountain Center for Occupational & Environmental Health

NVIDIA CUDA Center of Excellence

Center of Excellence for Biomedical Microfluidics

Center for Smart Sensors

Center for Neural Interfaces

Global Change & Sustainability Center

Carbon Capture Multidisciplinary Research Center

MULTIFACETED MATERIALS RESEARCH

The University of Utah Materials Research Science and Engineering Center, or MRSEC, is a $12M center supported by the National Science Foundation (NSF). This interdisciplinary center draws engineers and scientists together to tackle next-generation materials.

More than 100 peer-reviewed publications have resulted from collaborations among the Colleges of Engineering, Science, and Mines and Earth Sciences since the center began in Fall 2011. The center continues to thrive on these interactions and aims to become an internationally recognized leader in plasmonics and organic spintronics, two cutting-edge materials research fields.

In plasmonic devices, electromagnetic waves crowd into tiny metal structures, concentrating energy into nanoscale dimensions. Plasmonic devices could be harnessed for high-speed data transmission or ultrafast detector arrays. In organic spintronics, organic semiconductors are used to transport and control electron spin—rather than charge—for magnetic storage, quantum computing and non-volatile memory.

Beyond fruitful collaborations within the center, education and outreach play a strong role in the MRSEC. Center students, post-doctoral scholars, staff and faculty all participate in a wide range of activities from K-12 outreach to professional development and training.

The University of Utah MRSEC encourages student participation by supporting research experiences for undergraduate students. Approximately 10 undergraduates nationwide arrive at the U each summer through the NSF's flagship research experience for undergraduates (REU) program. This program is promoted in particular to students from underrepresented communities to help broaden diversity in materials research and education.

“The Center has created a unique opportunity for bringing researchers from around the campus together, who have rather different areas of expertise, to discuss and work on a set of common goals,” said Ajay Nahata, director of the University of Utah MRSEC and professor of electrical and computer engineering at the U. “The outcome of such collaborations will hopefully create new opportunities to generate multi-investigator funding.”

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LIVING IN UTAH

Utah continues to excel in a wide range of metrics from economic strength and growth to quality of life and education.

Both Salt Lake City and the State of Utah top rankings for economic outlook and career potential. An innovative environment provides fertile ground for launching small businesses.

SALT LAKE CITY

#1 Six Top Cities for High-Paying Jobs, Payscale.com
#1 Ten Cities Where You're Most Likely to Achieve the American Dream, The Equality of Opportunity Project
#1 Best Cities for Kids, MSN News
#1 Least Stressed City, CNNMoney
#2 Best Cities for Job-Seekers, Salt Lake City, Bureau of Labor Statistics

STATE OF UTAH

#1 Economic Outlook, American Legislative Exchange Council-Laffer State Economic Competitiveness Index
#1 Economic Dynamism, Information Technology and Innovation 2014 State New Economy Index
#1 Small Business Friendliness, Ewing Marion Kauffman Foundation
#2 Short-term Job Growth, U.S. Chamber of Commerce
#2 Fastest Wage Growth, Bureau of Economic Analysis
#3 Best State for Business and Careers, FORBES
#3 Best Places to Live, Gallup
#3 Higher Education Degree Output, U.S. Chamber of Commerce

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