THE UNIVERSITY OF UTAH COLLEGE OF ENGINEERING RESEARCH REPORT 2015

THE UNIVERSITY OF UTAH

FROM THE DEAN

Engineering education in Utah received a substantial vote of confidence during the 2015 legislative session with a targeted appropriation of $3.5 million in ongoing and $1 million in one-time funds for the Engineering Initiative. The effort was led by visionary state legislators at the urging of industry leaders who clearly made the connection between a highly educated technical workforce and economic development. This new appropriation will be further amplified by Utah's eight university presidents who, by statute, are required to match the new ongoing funds.

Since 2002, Utah's investment alone in the Engineering Initiative has totaled $15 million in ongoing funds and $10.45 million in one-time funds. This investment tracks closely with Utah's emergence as the #1 Top State for Business (Wall Street 24/7); #1 Top 10 Pro-Business States (Polina Corporate); #1 Best State for Business & Careers (Forbes); and #1 Economic Outlook (American Legislative Exchange Council-Laffer State Economic Competitive Index).

While other states are drastically reducing higher education budgets, Utah is investing heavily in its human potential. I feel fortunate to be leading the college in a place where industry, government and education leaders are working together to achieve a shared vision.

At the University of Utah, Engineering Initiative funds have been critical to our success in increasing enrollment, growing the size of the faculty and transforming the physical campus. In the past decade we have attracted many outstanding new faculty whose research and teaching are contributing to one of the most innovative and entrepreneurial colleges in the nation. I hope you enjoy a closer look at a selection of research activities that are highlighted in this year's report.

Richard B. Brown
DEAN, COLLEGE OF ENGINEERING

IN THIS ISSUE

ABOUT US

Dean, College of Engineering: **RICHARD B. BROWN**
Associate Dean for Research: **ERIC G. EDDINGS**
Associate Dean for Academic Affairs: **AJAY NAHATA**
Director, External Relations and Development: **MARILYN DAVIES**

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Rajesh Menon
/ Electrical and Computer Engineering

SILICON AT THE SPEED OF LIGHT

They say nothing is faster than the speed of light.

So why do computers and mobile devices use electrical currents to process and transmit information instead of light? University of Utah Electrical and Computer Engineering Associate Professor Rajesh Menon wants to change that.

He is deep into research on "silicon photonics," the science of using light waves in silicon chips to process and shuttle data. He is currently developing, and hopes to commercialize, microscopic devices for chips that can help turn this advanced concept into a reality.

"Light is the fastest thing you can use to transmit information," Menon said. "But that information has to be converted to electrons when it comes into your laptop. In that conversion, you're slowing things down. The vision is to do everything with light."

Menon said that if the data processed in a computer or smartphone was traveling as photons instead of electrons (the current method in all of today's electronics), machines could calculate and transmit data "millions of times" faster than today's machines. The benefits could be staggering for applications ranging from data centers and cloud computing, to video streaming, home computing and gaming.

"We are now at the starting point of the 'silicon photonics revolution,' which is almost identical to what happened in the semiconductor electronics revolution in the 1950s," he said.

Menon and his team of U researchers have been developing new "passive devices" for silicon chips that can manipulate the pathways of light that carry data. For example, they are creating "waveguides" that allow light waves to bend in different directions in much the same way electrical currents move through copper pathways on normal silicon chips. Another device they have created is a new smaller polarization beamsplitter on a silicon chip that can take one guided path of light and split it into two components.

His research team has discovered new algorithms that can make these devices much smaller than before and more efficient. As a result, hardware developers can pack more of these devices on a single silicon wafer than ever before, making the computer chip smaller, work faster, and perform more functions.

The advantage of using light over electrical currents in processing also has two other advantages: These new devices would produce little to no heat, and they require much less power, so mobile devices such as a smartphone or tablet could last significantly longer on a single charge.

In electronics, the electrons move through the copper pathways and create friction, resulting in heat, which is why a laptop will begin to feel hot on the bottom after prolonged use or a smartphone may heat up after a long conversation. Photonics, however, is much more power efficient.

"Ten to 20 years down the road, it could become all photonics where your phones or laptops do not produce much heat," Menon said, "and you may not have to charge your phone for a month, and that's pretty incredible."

While it will still be at least a decade before silicon photonics makes its way to consumer devices, Menon believes it will be used in data centers and supercomputers in just a few years.

"There are many smart people working on this," he said. "I'm pretty confident that you will see some application of silicon photonics in consumer devices very soon. It could be phones, it could be as simple as new kinds of displays or sensors."

UNDERSTANDING BRAIN INJURY

Each year, approximately 1,300 children in the U.S. are victims of severe or fatal head trauma from child abuse such as shaken baby syndrome, according to the National Institutes of Health. For many, the diagnosis comes too late — a child can go to a hospital several times before a doctor realizes the infant was a victim of abuse.

University of Utah Mechanical Engineering Assistant Professor Brittany Coats and her research team believe there is a better way to detect traumatic brain injuries (TBI). They are researching small structures in the "subarachnoid space," a thin layer between the skull and brain, to determine if they can be used as early indicators of head trauma.

This layer, about two to three millimeters thick, contains web-like structures called arachnoid trabeculae that tether the brain to the skull and help protect it during severe head rotations. Most devastating traumatic brain injuries are the result of head rotation as opposed to an impact to the skull, Coats said. If the brain rotates too much, these structures can get damaged, which could make the brain more vulnerable to future injury.

"Think of your brain as a bowl of Jello. If I rotate the Jello really fast, the outer edges have much larger deformations than the center," said Coats, who specializes in biomechanics, the study of how forces are applied to the human body. "This causes shearing within the brain and can result in diffuse traumatic brain injury which substantially affects your functional and cognitive capabilities."

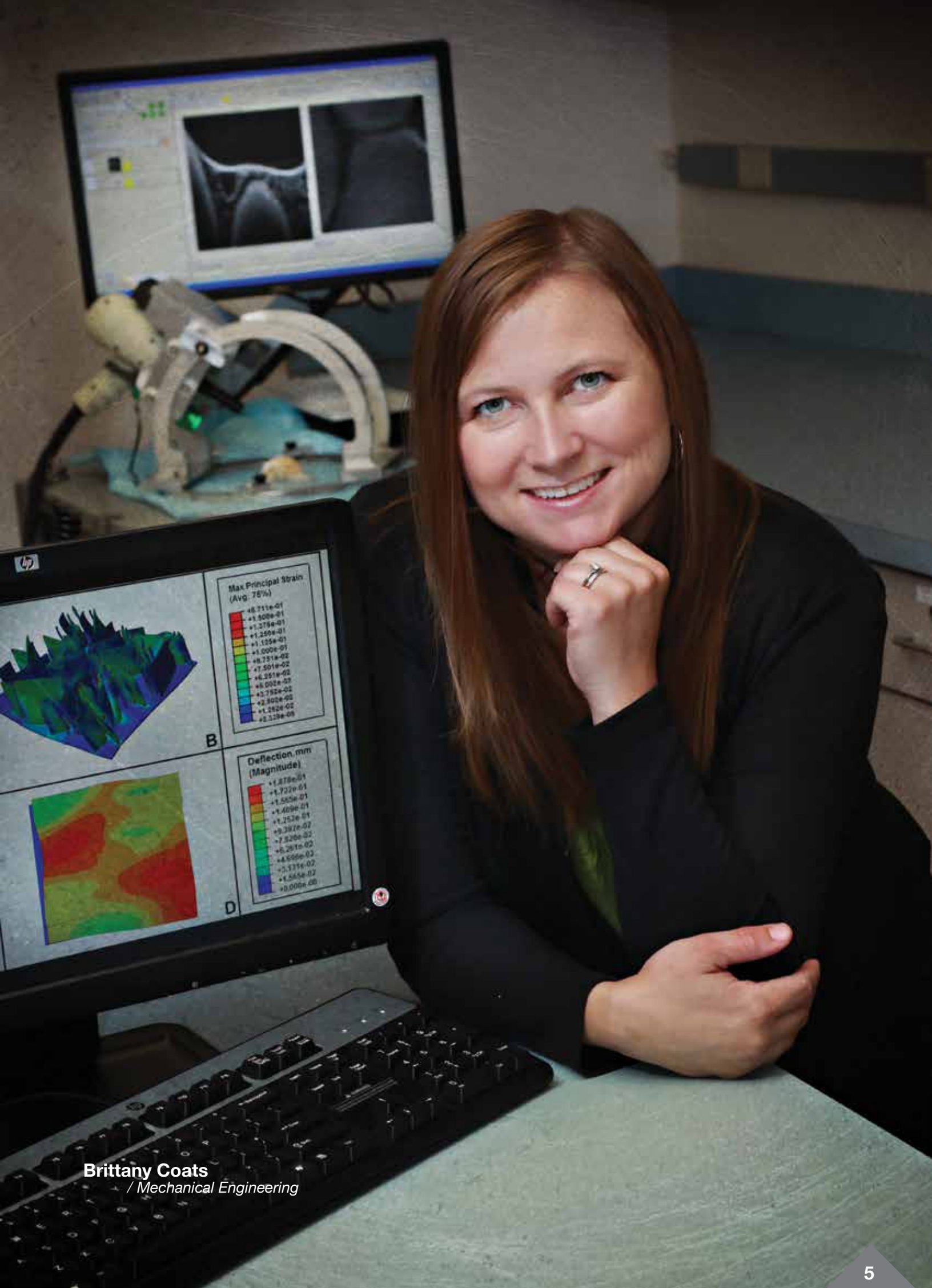
But little research has been done on this subarachnoid layer. So Coats examined the arachnoid trabeculae using optical coherence tomography, the same imaging technology used to probing the eye. From this information, she created a computational 3D model of the space and simulated a head rotation to determine how the arachnoid trabeculae influence the mechanics of the brain, which can be used to predict TBI. The result is a method that is much more sensitive and a better predictor of mild TBI than before. The model brings clinicians one step closer to more accurately determining whether a child was the victim of an accident or of abuse.

Coats and her team are currently researching how much force is required to damage these tethers, and if they heal or are replaced with scar tissue. This information could help physicians decide whether an area of the brain where the tethers were damaged is now more susceptible to injury. This research also could help athletes such as football players determine whether they have suffered enough damage to put them at risk for more serious injury later.

"It would mean an objective, more accurate way of diagnosing mild traumatic brain injury, as opposed to relying solely on a victim's symptoms," Coats said. "Mild TBI is dangerous because a person may feel OK and go back out into their regular daily activities, then get a second impact in which the injuries can be much worse."

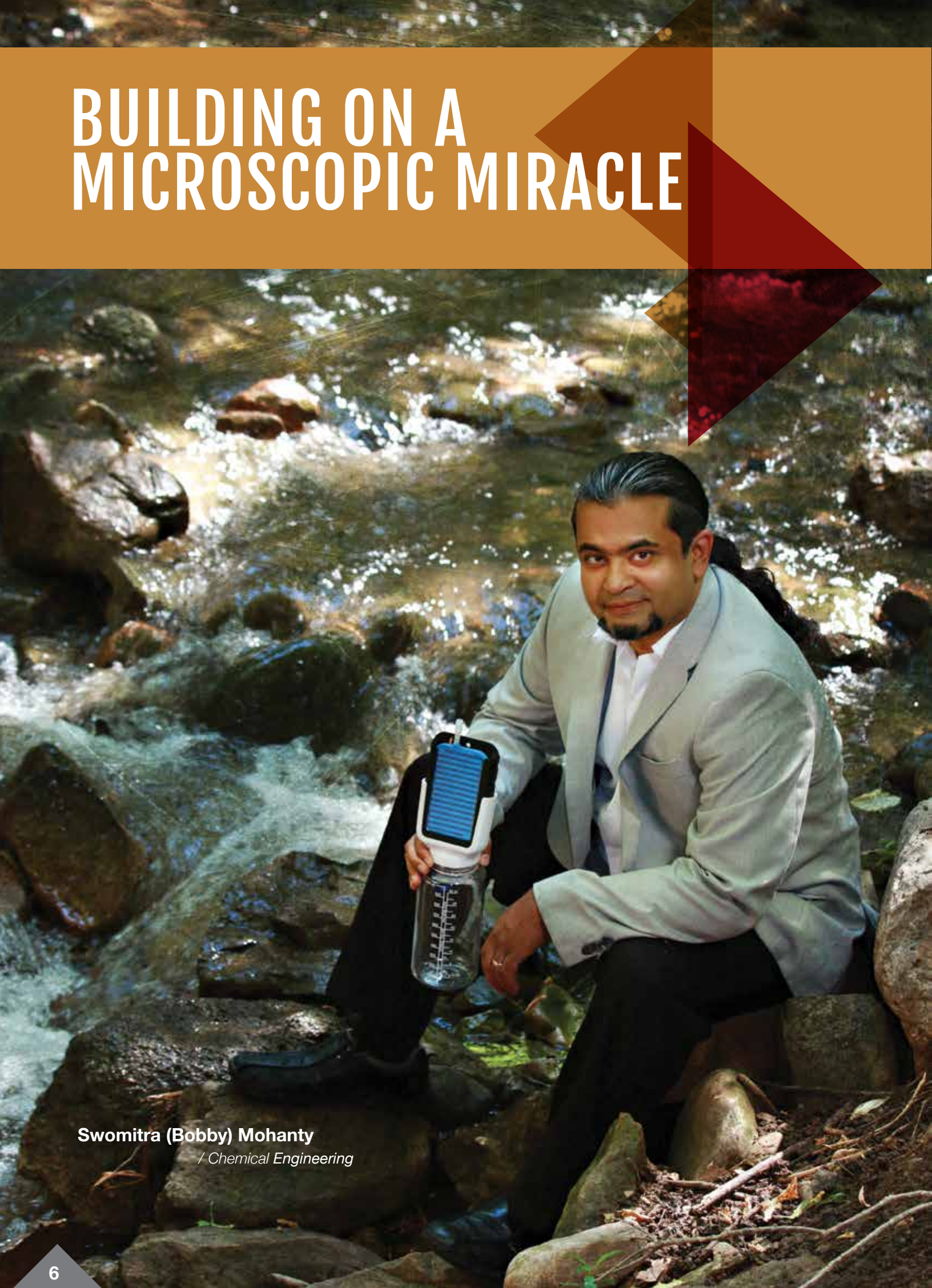
Currently, however, there is no scanning device that looks for damage in this subarachnoid space, but Coats believes her research will ultimately lead to one.

"If we came up with some tool to assess if these structures were damaged and we knew these damaged structures led to an increased risk for more serious head injury, we could develop more informed treatment strategies for managing patients with mild TBI," she said.



Brittany Coats
/ Mechanical Engineering

BUILDING ON A MICROSCOPIC MIRACLE



Swomitra (Bobby) Mohanty
/ Chemical Engineering

Every summer, Swomitra Mohanty would visit his family in India and sometimes see the horrific disease and dismal living conditions that plagued many residents there.

While his family resided in a comfortable home, just across the street lived a woman and her children in a hut, he said, underscoring the stark contrast between the rich and poor in his family's native country.

"It was just walls and straw," he said of their neighbor's home. "I thought, 'This is absurd. How can I be right here while this person is 30 feet away from me and is barely surviving on what she begs for or picks up and sells?' And their conditions were not very sanitary."

The economic plight of his family's country, as well as other developing nations around the world, is what helped shape Mohanty's passion to become an engineer.

"If I'm going to be an engineer and a professor, then I should be doing something every single day to make the place better in some small way," said Mohanty, an assistant professor of chemical engineering at the University of Utah.

Mohanty may have found that in a microscopic material no bigger than one-thousandth the width of a human hair — a titanium dioxide nanotube that could be a key to helping stave off thirst and tuberculosis in developing countries.

Mohanty has been spending his first four years at the university developing uses for this unique form of nanotube, which was initially developed by Manoranjan Misra, a U professor of metallurgical engineering and chemical engineering. From it, he and his colleagues are on the verge of creating two devices: a breathalyzer that can identify carriers of tuberculosis and a water purifier that can destroy the bacteria in unclean water via the sun's rays. Both devices currently have prototypes and are going through extensive testing with positive results, he said.

During a 2008 visit to Orissa, India, Mohanty learned from a doctor that tuberculosis, an often-fatal infectious disease that attacks the lungs, was rampant in the country's rural areas.

"In India, tuberculosis has been a huge problem for a long time," Mohanty said. "One of the reasons is they can't find it quickly enough."

In order to accurately detect tuberculosis in a patient, doctors typically test blood or sputum at a clinic. But Mohanty's lab is developing a portable breathalyzer that can determine if the person may have the disease and needs further testing, and it will at least confirm if the person does not have the bacteria.

The patient blows into a bag, and the breath passes through a sensor made up of the titanium dioxide nanotubes. Based on the results, the sensor will alter the electrical current recorded on a potentiostat, a box that reads electrochemical changes. Mohanty hopes to deploy about a hundred prototypes of his breathalyzer in Mumbai as early as this fall for more tests.

Meanwhile, Mohanty, along with research associate Krista Carlson, also has been developing a water purifier the size of a smartphone that kills bacteria with the same nanotubes by just shining light on a built-in solar panel.

Dirty water is poured into one end of the device and passes through a coil of the titanium dioxide nanotubes. That process creates radicals, a chemical species which kills the bacteria in the water. Additionally, the device also adds a small amount of voltage to create more radicals that clean the water even more.

"I can take one liter of water and treat it in three minutes, and that's not even optimized," Mohanty said. "And this is at concentrations of bacteria well above what you would find in nature."

Mohanty decided to focus his research on a new water purifier also while on a trip to India. He learned that scientists there are trying to create new low-cost water-purification technologies.

He now has a prototype and will begin field tests locally. He said he also could begin selling the device in stores for hikers in about a year and a half.

"It's a dream come true to see your research actually influence someone's life," he said. "Not very many people get to do that."

SLOWING DOWN MULTIPLE SCLEROSIS

Tara Deans doesn't have what you would consider normal family dinner conversations.

The University of Utah assistant professor of bioengineering likes to talk with her husband — who himself is a neuroscientist at the U. — about the biology of the human brain and how their work might improve it.

"We're always troubleshooting over dinner," she said, laughing. "We talk about his work a lot and my work a lot. One day we were talking, and the subject of multiple sclerosis came up."

Deans specializes in "synthetic biology," the science of designing and building new biological components and systems. That one night, she realized her research could have a dramatic impact on understanding and ultimately slowing down the progression of MS, a debilitating disease of the central nervous system that interferes with the flow of information from the brain to the body. In the later stage of MS, victims can have trouble walking, talking and eating. But Deans believes the way she manipulates human cells could one day help patients.

MS is believed to be an autoimmune disease in which the body's immune system attacks myelin, the waxy coating that covers the tail — or axon — of the brain's neurons. The axons are where the brain's electrical impulses travel from neuron to neuron, and the waxy coating allows the signals to move quickly, which is essential for the brain to function properly. For a person with MS, the immune cells attack and eat away at the myelin until the axon is exposed. Ultimately, the axon itself becomes damaged and eventually degrades.

"Everything starts to disappear, and over time you enter a second, more debilitating state, which is when most patients are wheelchair-bound," Deans said.

But the professor is working on the ability to engineer some cells to record how the disease progresses and other cells to possibly repair the damaged myelin before the immune system works its way to the neuron's tail.

Deans equates her work in synthetic biology to that of an electrical engineer. She takes parts of DNA and creates cells that can perform certain functions in the body such as regenerating tissue or creating blood platelets to stop a wound from bleeding.

"It's almost like making a cell into a computer — it can record, it has memory, it can count," she said. "It's a really important first step into building these more complicated, useful circuits in higher organisms."

To better understand the progression of MS, Deans is engineering a type of cell that has memory and can "record" the development of the disease in a human and figure out what cells are present when MS strikes. She's also engineering different cells that can repair the damaged myelin that covers the tails of the neuron to help slow the progression of the disease.

"If we can actually look at how the disease progresse, then we might be able to find some novel area to target for therapy," she said.

Deans, who received her bachelor's degree at Washington State University, first became interested in synthetic biology while working on her Ph.D. at Boston University. Before coming to the U, Deans wanted to apply synthetic biology to improving human health so she joined a lab at Johns Hopkins University where she worked with combining synthetic biology with biomaterials, stem cells, and tissue regeneration.

"As synthetic biologists, we build tools for various applications," she said. "So with all of the projects in my lab, we try to figure out an aspect of the problem and then we go back and we design, build, test, learn and then redesign. It's like the circle of life in our lab."

Tara Deans
/ Bioengineering

PROFESSORSHIPS AWARDED

MILIND DEO AND ANIL VIRKAR

Though he's been teaching at the University of Utah for more than 42 years, Materials Science and Engineering Distinguished Professor Anil Virkar is not about to slow down.

"Whenever I feel the need to slow down I can, but I don't want to just abruptly cut it down," he said about his career at the university thus far.

Besides, Virkar's best years may be ahead of him.

Both Virkar and University of Utah Chemical Engineering Chairman Milind Deo were awarded endowed professorships during a ceremony May 1 at the James L. Sorenson Molecular Biotechnology Building. The event was hosted by College of Engineering Dean Richard Brown and attended by U President David Pershing and Senior Vice President of Academic Affairs Ruth Watkins.

Deo was appointed to the Peter D. and Catherine R. Meldrum Endowed Professorship in Chemical Engineering while Virkar was given the H. Kent Bowen Endowed Professorship in Materials Science and Engineering.

"Professors Deo and Virkar are exceptional faculty members who have had great impact through their vigorous re-

search programs in energy and electrochemistry, respectively," said Brown. "And we are truly grateful to Peter and Catherine Meldrum and to Kent and Katherine Bowen for their generous donations that established these endowed professorships."

Deo received his undergraduate degree from the Indian Institute of Technology in Chennai (formerly Madras) and a Ph.D. in chemical engineering from the University of Houston in 1987. He joined the U's Department of Fuels Engineering in 1989, which merged with the Chemical Engineering Department in 1992. Deo became chair of the department in 2013.

His research addresses oil and gas-enhanced oil recovery, reservoir engineering, and carbon dioxide sequestration, and he established the U's Petroleum Research Center. He served as the associate dean for academic affairs for the U's College of Engineering from 2006 to 2013.

"It's a great honor," Deo said of his endowed professorship. "It's a validation of things that I have done at the university, and it's more motivation to continue to contribute to the science and technology of chemical engineering."

Meanwhile, Virkar has so far called his career at the university "a great ride."

"I have had great support from the administration both at the college level and at the university level," he said. "It has been a great pleasure to be a faculty member in the College of Engineering led by many excellent deans over the years."

Virkar received his undergraduate degree at the Indian Institute of Technology in Mumbai and his Ph.D. at Northwestern University. Shortly after, he arrived at the University of Utah first as a post-doctoral fellow and then professor where he has remained his entire career.

During his time here, Virkar has co-founded several companies, including Colorado-based Versa Power Systems and Materials and Systems Research, Inc., in Salt Lake City. Most recently, he co-founded Nano-Oxides, Inc., for the synthesis of nanosize oxide powders. His main research is focused on fuel cells, batteries, multi-species transport and the fabrication of ceramics.

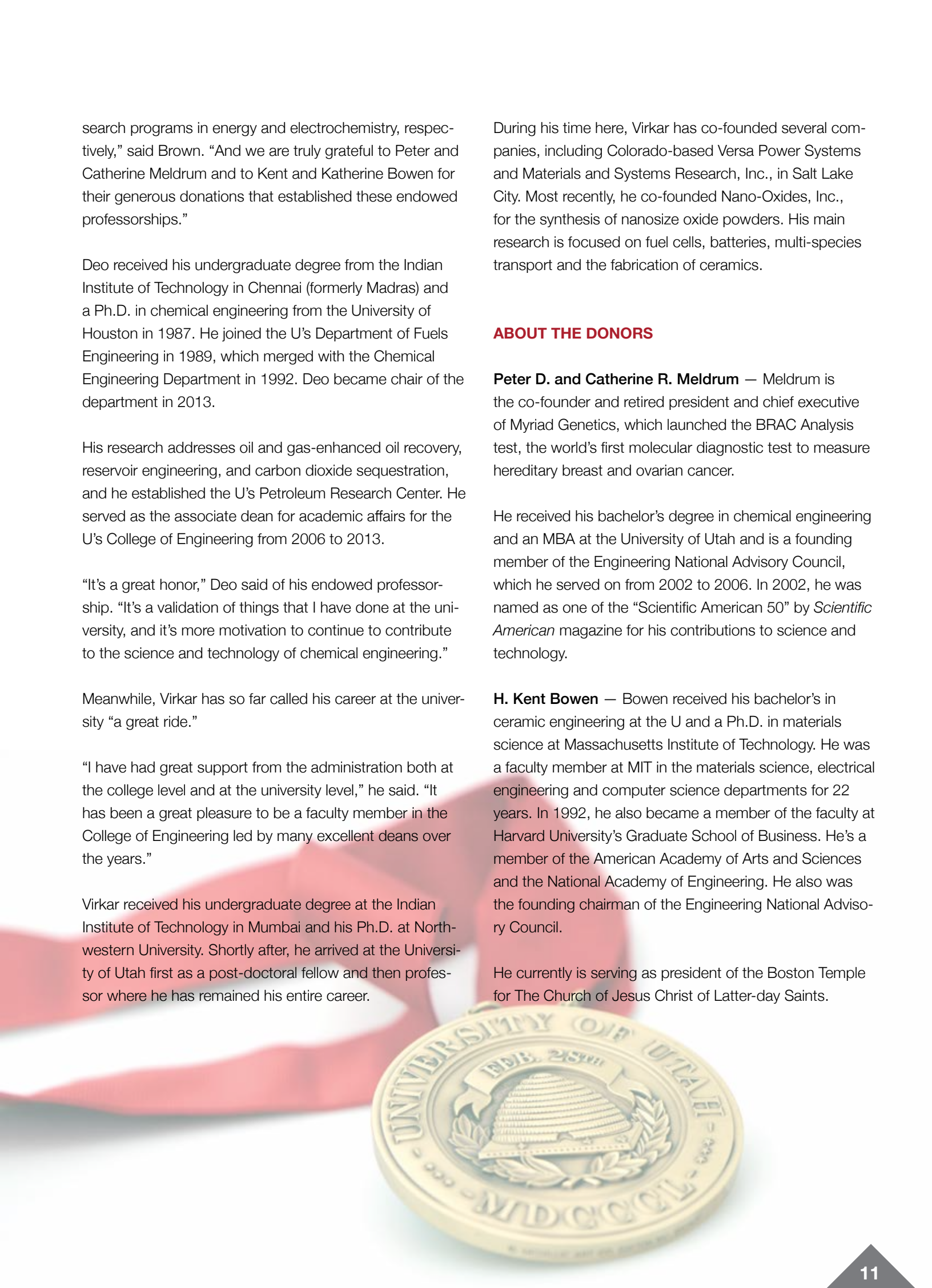
ABOUT THE DONORS

Peter D. and Catherine R. Meldrum — Meldrum is the co-founder and retired president and chief executive of Myriad Genetics, which launched the BRAC Analysis test, the world's first molecular diagnostic test to measure hereditary breast and ovarian cancer.

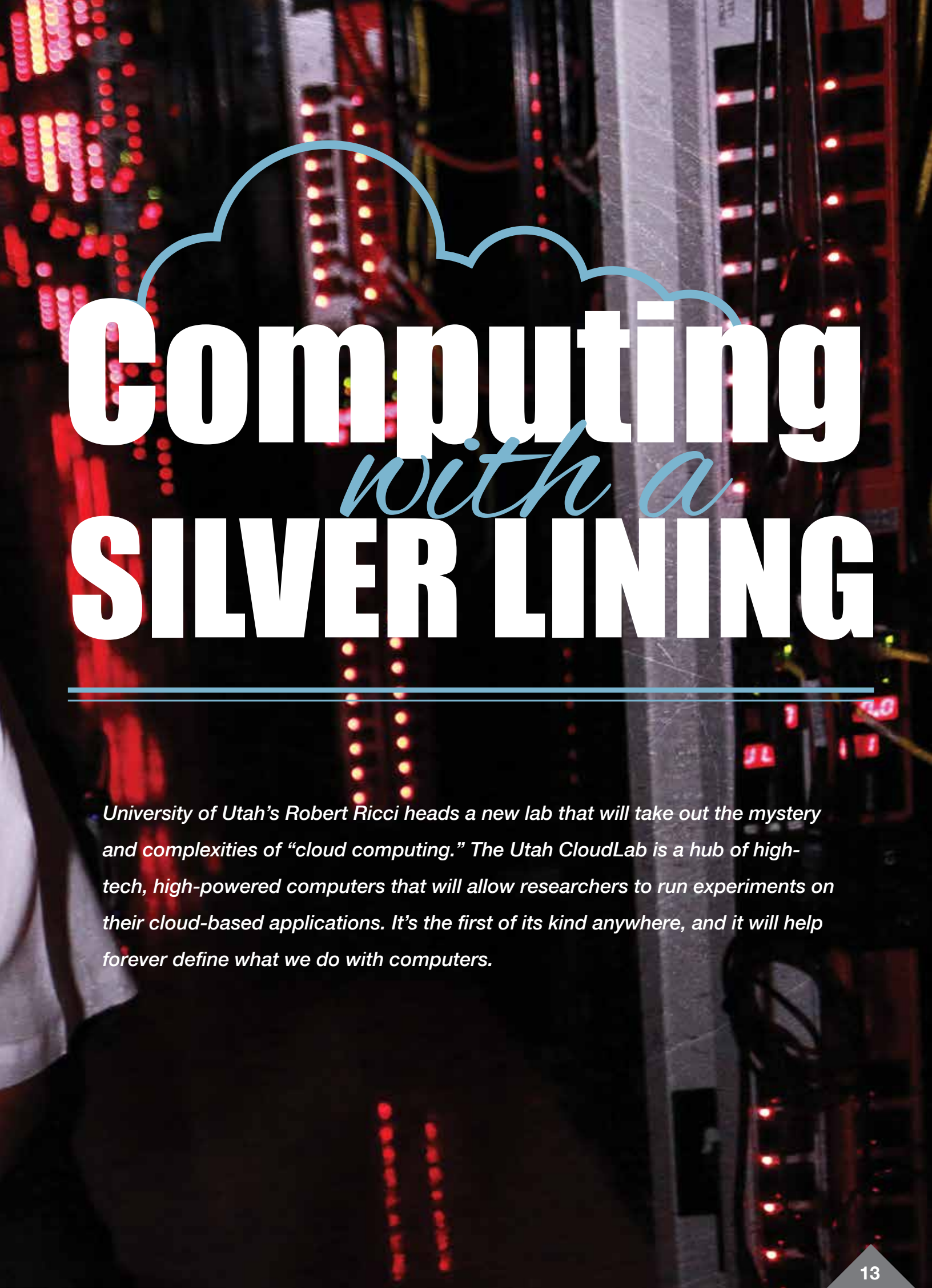
He received his bachelor's degree in chemical engineering and an MBA at the University of Utah and is a founding member of the Engineering National Advisory Council, which he served on from 2002 to 2006. In 2002, he was named as one of the "Scientific American 50" by *Scientific American* magazine for his contributions to science and technology.

H. Kent Bowen — Bowen received his bachelor's in ceramic engineering at the U and a Ph.D. in materials science at Massachusetts Institute of Technology. He was a faculty member at MIT in the materials science, electrical engineering and computer science departments for 22 years. In 1992, he also became a member of the faculty at Harvard University's Graduate School of Business. He's a member of the American Academy of Arts and Sciences and the National Academy of Engineering. He also was the founding chairman of the Engineering National Advisory Council.

He currently is serving as president of the Boston Temple for The Church of Jesus Christ of Latter-day Saints.



Robert Ricci
/ School of Computing



Computing *with a* SILVER LINING

University of Utah's Robert Ricci heads a new lab that will take out the mystery and complexities of "cloud computing." The Utah CloudLab is a hub of high-tech, high-powered computers that will allow researchers to run experiments on their cloud-based applications. It's the first of its kind anywhere, and it will help forever define what we do with computers.

For the average computer user who just likes to read email and surf the web, the concept of "the cloud" — the basis for everything from network security to Netflix and e-commerce — is as ethereal and difficult to grasp as the name suggests.

But the University of Utah's School of Computing is working to clear the air on this seemingly intangible idea. In the fall of 2014, the National Science Foundation gave a three-year, $10 million grant to the U and five other institutions to build labs for studying cloud computing and allow researchers to conduct scientific experiments on their cloud-based applications and services. The U is the lead team for the project.

The Utah CloudLab, which is the first of three labs to come online as part of the NSF grant, is housed in the University of Utah's Downtown Data Center near 900 South and West Temple in Salt Lake City. The lab is run by the School of Computing's Flux Research Group.

Inside the 74,000-square-foot data center, which also is the home to the university's digital administrative services, is a small section dedicated to CloudLab. The lab now contains 315 new Hewlett-Packard ARM-based computers, representing 2,500 processing cores that can crunch and move data at lightning speeds.

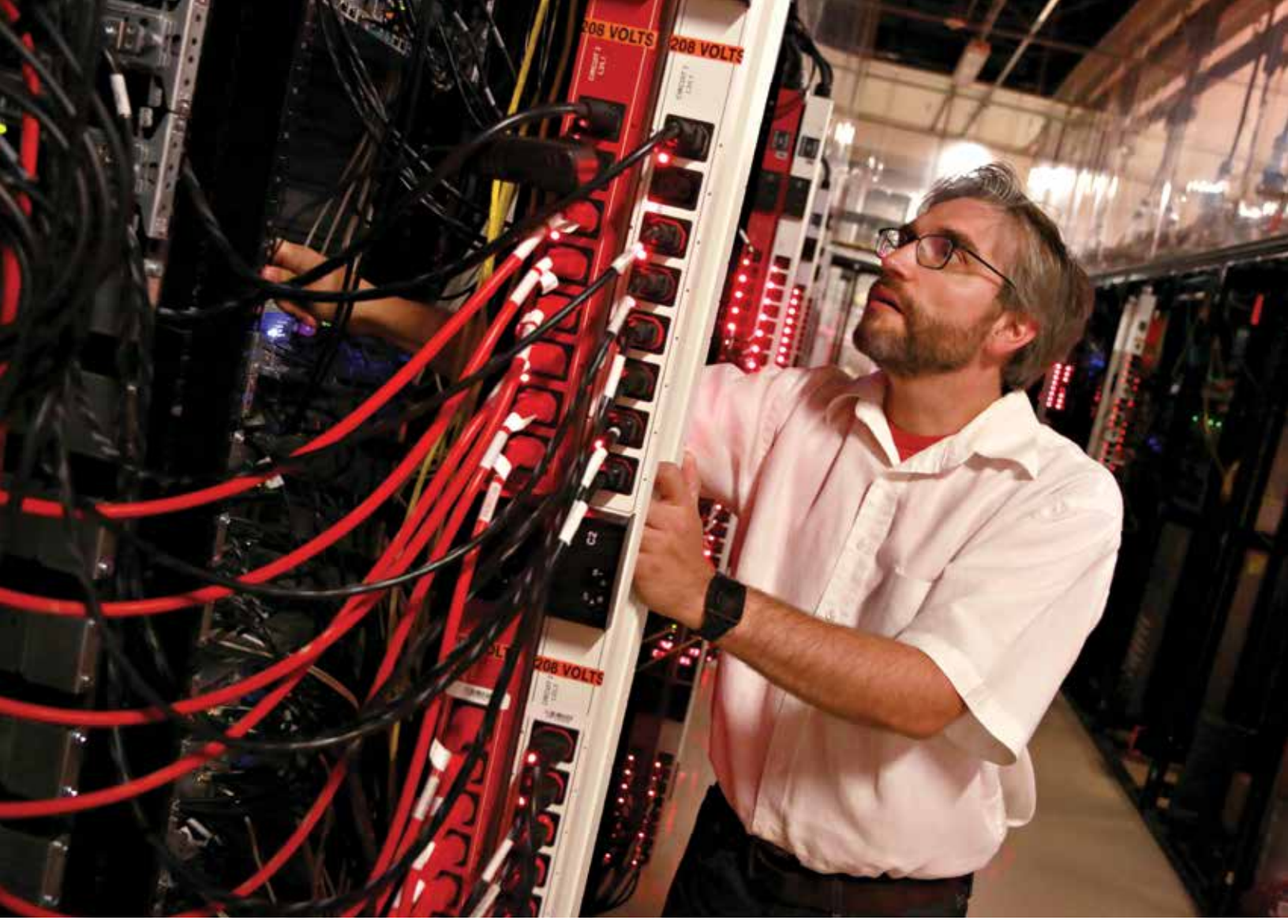
"This facility is about enabling forward-looking research, so we wanted to get a mix of things that you will definitely find in a data center now and things you might find in a data center in the future," said University of Utah Computer Science Research Assistant Professor Robert Ricci, who heads the lab.

About 350 researchers from the U.S., Europe, South America and Asia already have run more than 3,500 experiments in the first six months since the lab's launch in December, Ricci said.

The "cloud" has many definitions, but what it mostly means is the rental or use of computers over the Internet (usually in data centers) for storage or processing power. Online services such as Amazon and iTunes use cloud computing to sell their products. Netflix uses the cloud to store its tens of thousands of streaming movies. Dropbox customers use computers in the cloud to store their important data.

The facility allows scientists to rent out a slice of the lab to test their services or applications in the cloud. With it, they can study the fundamental properties of the cloud and what it can be in the future. They also can look at ways to support applications that many thought were not possible to run in the cloud today. For example, engineers can study how to remotely control robots via the cloud. Others can test newer, faster ways to store data in the cloud. And more research can be done on machine virtualization, where one computer can become many virtual computers by connecting users via a network. The lab can also be used to test network security as well as to look for better ways to protect medical data.

"We want to make sure that researchers have access to the resources they need to keep working on the cloud," Ricci said. "We want to let researchers build their own clouds from the ground up on top of our hardware."



In addition to the U, Clemson University in South Carolina and the University of Wisconsin-Madison are also building cloud-computing labs through the grant. Those two other universities are using more traditional Intel-based computers for their labs, and all three are connected together in the same network. Ricci expects to nearly double the number of computers in the Utah CloudLab by the end of the three-year grant.

He said the University of Utah was chosen to build its CloudLab because of its long-standing work on computer networking, which began with the U's existing Emulab, a network set up more than 15 years ago that allows researchers to develop, debug and evaluate custom computer network systems.

"We have been building infrastructure that is related to this for a very long time," he said.

Ross Whitaker, director of the U's School of Computing, agrees that his department was the right choice to pursue future technologies in cloud computing.

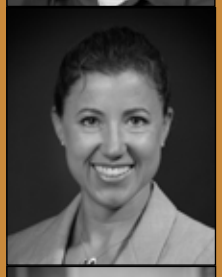
"The School of Computing has been the epicenter of cloud computing research and continues to be a leader in developing infrastructure to enable diverse applications of cloud technology," he said. "Our innovative environment is what draws outstanding researchers and students to the University of Utah and allows these collaborative efforts to succeed."

Ricci, along with School of Computing faculty collaborators Eric Eide and Kobus Van der Merwe, are receiving about $4.5 million of the total award, which is being shared with the University of Wisconsin, Clemson, University of Massachusetts, Raytheon BBN Technologies and US Ignite.

NEW FACULTY

ROBERT BOWLES
Bioengineering
Ph.D., biomedical engineering, Cornell University
Tissue engineering, regenerative medicine, gene therapy, back pain

DANIEL FAGNANT
Civil and Environmental Engineering
Ph.D., civil engineering, University of Texas
Automated vehicles, transportation safety, traffic operations



AZAREE LINTEREUR
Civil and Environmental Engineering, Nuclear Engineering Program
Ph.D., nuclear and radiological engineering, University of Florida
Radiation detection, coincidence and multiplicity counting

MASOOD PARVANIA
Electrical and Computer Engineering
Ph.D., electrical engineering, Sharif University of Technology
Mathematical models for power system optimization

PIERRE-EMANNUEL GAILLARDON
Electrical and Computer Engineering
Ph.D., electrical and electronics engineering, École Centrale de Lyon
Semiconductor processes, digital architectures, reliability in nanoelectronics

LADISLAV KAVAN
School of Computing
Ph.D., computer science, Czech Technical University
Computer graphics and animation, physics-based simulation

RYAN STUTSMAN
School of Computing
Ph.D., computer science, Stanford University
Distributed systems, operating systems, and databases

ADITYA BHASKARA
School of Computing
Ph.D., computer science, Princeton University
Algorithms and theoretical computer science, computational learning theory

ALEXANDER LEX
School of Computing
Doctoral Program in Computer Science, Graz University of Technology
Data visualization and analysis, human-computer interaction

TUCKER HERMANS
School of Computing
Ph.D., robotics, Georgia Institute of Technology
Autonomous learning and perception in robots

KERRY KELLY
Chemical Engineering
Ph.D., envioronmental engineering, University of Utah
Air quality, carbon management, evaluation of emerging energy technologies

SWOMITRA (BOBBY) MOHANTY
Chemical Engineering
Ph.D., biomedical engineering, University of Wisconsin, Madison
Renewable energy, nanotechnology, biosensors, biofuels

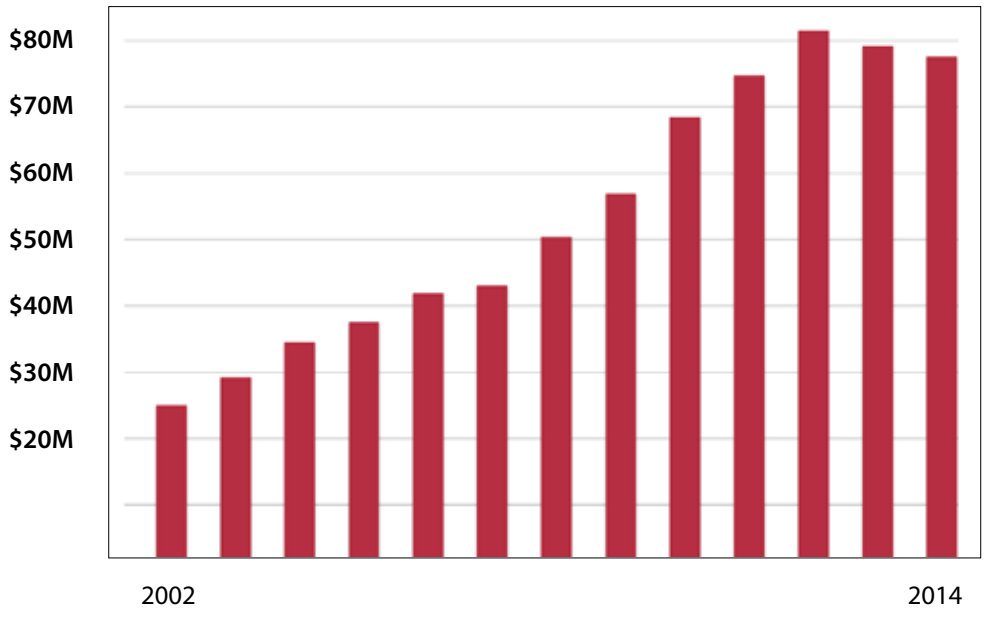
JIYOUNG CHANG
Mechanical Engineering
Ph.D., mechanical engineering, University of California, Berkeley
Wearable electronics, nanofabrication, synthesis of nanostructures

ROSEANNE WARREN
Mechanical Engineering
Ph.D., mechanical engineering, University of California, Berkeley
Nanomaterials for energy storage, renewable energy

BY THE NUMBERS

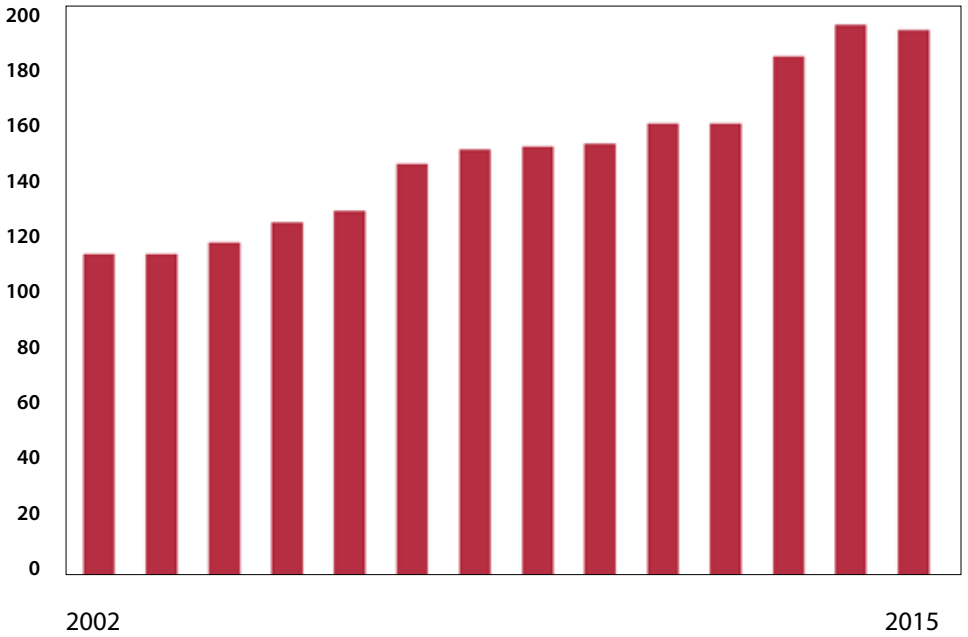
RESEARCH EXPENDITURES

The University of Utah's College of Engineering is one of the West's leading research institutions with $77.6 million in research funding for 2014. The college was ranked 37th of 205 U.S engineering schools in research expenditures, according to the latest statistics from *Profiles of Engineering and Engineering Technology Colleges*, American Society of Engineering Education (2014).

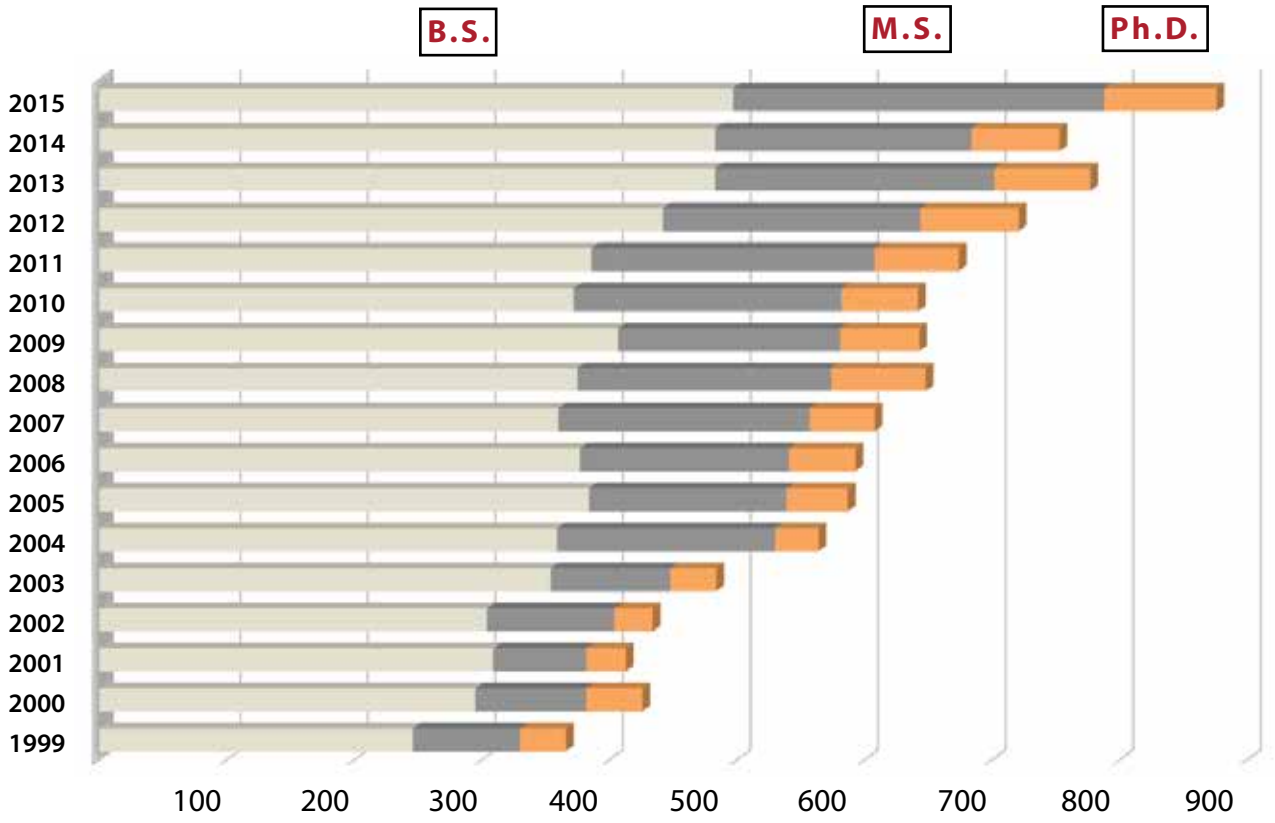


TENURE-TRACK FACULTY

The college continues to grow rapidly in the numbers of both faculty and graduates. This year, the college has 188 tenure-track faculty members, a 71 percent increase since 2002. Meanwhile, the college's student enrollment is rising. A decade ago, 7 percent of incoming students to the university indicated an interest in studying engineering or computer science. Today, 14 percent are interested in those fields. In 2014, the U's undergraduate and graduate enrollment in engineering each ranked 46th in the nation (out of 352 and 265 schools reporting, respectively).



GRADUATES

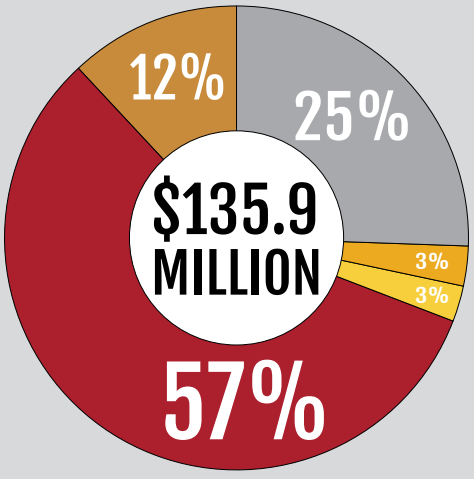


In 2015, the college awarded 876 undergraduate and graduate degrees, a 16 percent increase from just the year before and a number that has more than doubled since 2002.

The University of Utah's College of Engineering is growing in recognition. In 2014, it was 57th in *U.S. News & World Report*'s "America's Best Colleges" ranking of undergraduate engineering programs, up from 70th in 2008. Its graduate ranking is 56th, and the bioengineering department moved up eight positions to 26th. Also, the 2014 Academic Ranking of World Universities puts the U's computer science department among the top 75 programs in the world.

Since 2006, the U's College of Engineering has been either No. 1 or No. 2 in the country each year in the number of spinoff companies generated from the college with a total of 53 new startups.

BUDGET 2013 – 2014



- research expenditures
- USTAR
- state budget
- other
- gifts

DISCIPLINES

The University of Utah's College of Engineering is internationally recognized for its innovation, educational mission, commercial development and ties to top industry leaders. This premier research institution is made up of seven departments and six multi-disciplinary academic programs.

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, circuit design, 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 structural properties. Research expertise lies in nanomaterials, ceramics and composites, polymers, electronic materials, and computational methods for engineering applications.

CHEMICAL ENGINEERING
Chemical engineering spans diverse topics such as chemicals and biochemicals, medical devices, semiconductors, food processing, personal care products, water purification, energy, combustion, minerals and petroleum production, transport and refining.

SCHOOL OF COMPUTING
The School of Computing offers degrees at all levels in computer science. Research strengths span the field, including theory, formal methods, architecture, networking, operating systems, languages, security, scientific computing, data management and analysis, artificial intelligence, graphics, visualization, and human-computer interaction.

ENTERTAINMENT ARTS AND ENGINEERING PROGRAM
This No.1-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 research and education in nuclear power, nuclear reactor modeling, nuclear medicine, nuclear forensics, radiochemistry, radiation detection, radiation shielding for space missions, and radiation transport computational techniques.

PETROLEUM ENGINEERING PROGRAM
This program for working professionals and students 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 design, 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
NSF Materials Research Science and Engineering Center
U.S.-Pakistan Centers for Advanced Studies in Water
Center for Engineering Innovation
Utah Center for Nanomedicine
Utah Center for NanoBioSensors
Utah Center for Nanomaterials
Utah Center for System Integration
Utah Center for Interface Sciences
Utah Center for Advanced Imaging Research
Utah Center of Trace Explosives Detection
Center for Neuroimage Analysis
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 Neural Interfaces
Global Change & Sustainability Center
Carbon Capture Multidisciplinary Simulation Center
Intel Parallel Computing Center
Center for Extreme Data Management Analysis and Visualization

ALUMNI SPOTLIGHT

BRETT HELM

Chairman and CEO
DB Networks

Whether he was running a multimillion-dollar company, flying combat missions for the U.S. Air Force or kicking up sand and dirt in an international off-road motorcycle race, University of Utah engineering graduate Brett Helm was and always will be led by two simple principles: take reasonable risks and make good decisions.

The strategy has served him well. After graduating from the University of Utah in 1988 with a bachelor's degree in industrial engineering, Helm co-founded @Home Corp., one of the first high-speed cable Internet service providers in the U.S. He was also chief executive and founder of networking companies, IPivot, and Coradiant, and he was a co-founder and investor in Sanera Systems, a data storage technology company. He is currently co-founder and CEO of cyber-security company, DB Networks.

DB Networks designs products that monitor and protect databases. The company has developed unique sensor technology that decodes database traffic as well as additional technology that helps detect database breaches in real time to prevent theft of content. "This behavioral analytics provides protection against insider threats, external attacks and advanced persistence threats," Helm said.

DB Networks is the newest in a string of companies Helm built involving networking, application performance management and cybersecurity.

"Industrial engineering is about taking the latest technology to the economy at that time," he said about using his education to his advantage. "The economy now is communications-related."

Helm, who now lives near San Diego and is a member of the U's Engineering National Advisory Council, was a navigator in a B52 bomber and flew 26 combat missions during Operation Desert Storm. He's also passionate about motorcycle racing and has won a dozen SCORE International (Southern California Off Road Experience) and Baja championships.

Helm credits his years attending the University of Utah's College of Engineering with instilling in him the motivation to keep moving forward and to stay focused in an ever-changing business landscape.

"It was difficult going to school and working full time. And then when you have a child, that pressure is even greater," he said about his push to succeed at the U. "But I did it because I was investing in myself and my family. If you start off investing when you're 20, it pays off when you're 50. The number one investment should be in yourself."

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LIFE IN UTAH

We have a motto here in Utah: "This is the place." And that certainly is true today. This is the place for explosive economic growth. This is the place for technological innovation. And this is the place to take in the world's most beautiful and awe-inspiring natural wonders. Utah and Salt Lake City have received many accolades in the past year, ranking at the top in the nation in a variety of categories.

STATE OF UTAH

#1 Best States for Business – Forbes
#1 Economic Outlook – American Legislative Exchange Council
#1 States with Total Job Growth – U.S. Bureau of Labor Statistics
#1 Best States to Repay Student Loans – Schools.com
#1 Happiest States in America – WalletHub
#2 Best Business Climate – Business Facilities Magazine
#3 Top States for Business – CNBC
#3 Top 10 States for Economic Performance – U.S. Bureau of Labor Statistics
#4 Lowest Unemployment Rate in America – U.S. Bureau of Labor Statistics
#4 Top 10 States for Workforce Talent – U.S. Census Bureau American Community Survey
#4 Top 10 States for Technology and Entrepreneurship – U.S. Census Bureau American Community Survey
#5 Most Bicycle-Friendly States – BikeLeague.org
#6 Best U.S. Cities for Affordable Getaways – Travel + Leisure

SALT LAKE CITY

#1 nine Hot Startup Cities That Aren't San Francisco or New York - Entrepreneur
#1 10 Best Midsize Cities for College Graduates – MyLife
#3 Best Cities for Recent Grads – Kiplinger
#4 Best Cities for Young Professionals – Forbes
#5 Top 10 Best Downtowns – Livability
#6 Best Performing Cities – Milkin Institute

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