

IMPLANTABLE DEVICES
NANOPHOTONICS
SEMICONDUCTORS
ELECTROMAGNETICS
EMBEDDED SYSTEMS
WATER RESOURCES
TRANSPORTATION
VLSI SYSTEM DESIGN
POWER ENGINEERING
BIOMEDICAL DEVICES
PHOTOBIOREACTORS
NANOTECHNOLOGIES
SCIENTIFIC COMPUTING
INNOVATE
ELECTRICAL SYSTEMS

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FROM THE DEAN

BIG DATA
PETTABYTE
HYDRAULIC FRACTURING
CATALYSIS
TISSUE ENGINEERING
GEOMETRIC MODELING
BIOMECHANICS



As the University of Utah gears up for another season of PAC-12 athletics, the College of Engineering is preparing to compete academically as a PAC-12 contender. As Utah's flagship engineering program, the College embraces the opportunity to redefine excellence among a new set of peers. We are asking our faculty leaders, advisory board members and corporate partners what it means to be a high-performing school when the competition now includes several of the top engineering programs in the nation.

For more than a decade, Utah's investments from the Engineering Initiative and the Utah Science Technology and Research Initiative have helped accelerate our rate of growth in student and faculty size, research expenditures and degree output. The University of Utah is the pipeline for engineering and computer science graduates in a state that has earned the most top 10 economic rankings of any state in the U.S.

To help sustain Utah's tech-driven economy, the College must continue to grow in size, quality and reputation. In critical metrics, the College compares well among PAC-12 engineering programs, including: average quantitative GRE's for entering graduate students; percentage of faculty members in the National Academy of Engineering; total research expenditures; and the average amount of research expenditures per faculty.

In other categories, the competition gets tougher. The University of Utah's tuition is lowest among PAC-12 schools, and we are comparatively small in undergraduate and graduate engineering enrollments, despite years of accelerated growth. While competing academically with Stanford, Berkeley and USC sets a high bar, this comparison will help the College of Engineering rise to the challenge.

Size: Building on an 84% increase in graduates in the last decade, we envision a College of Engineering substantially larger in both undergraduate and graduate enrollments. We are on a trajectory for growth enhanced by strategic recruiting and outreach programs, and sustained by continuing state investments.

Quality: The College of Engineering will be raising admission standards to ensure the students we accept are better prepared to succeed. We will continue to recruit exceptional faculty who will advance the College's strategic objectives, and award tenure to faculty who meet our high standards for research, service and effective teaching.

Reputation: We will aggressively promote programs and attributes that differentiate the College of Engineering, such as technology innovation, entrepreneurship, and large-scale, interdisciplinary research successes. Best known for its pioneering efforts in computer graphics, scientific visualization, fossil energy, robotics, neural interfaces and MEMS, the College has emerging strengths in data science, nanotechnology and nuclear engineering.

I hope you will enjoy reading this year's report. I think you will find our new association with the nation's top engineering schools is generating excitement about our vision for the future.

Richard B. Brown
DEAN, COLLEGE OF ENGINEERING

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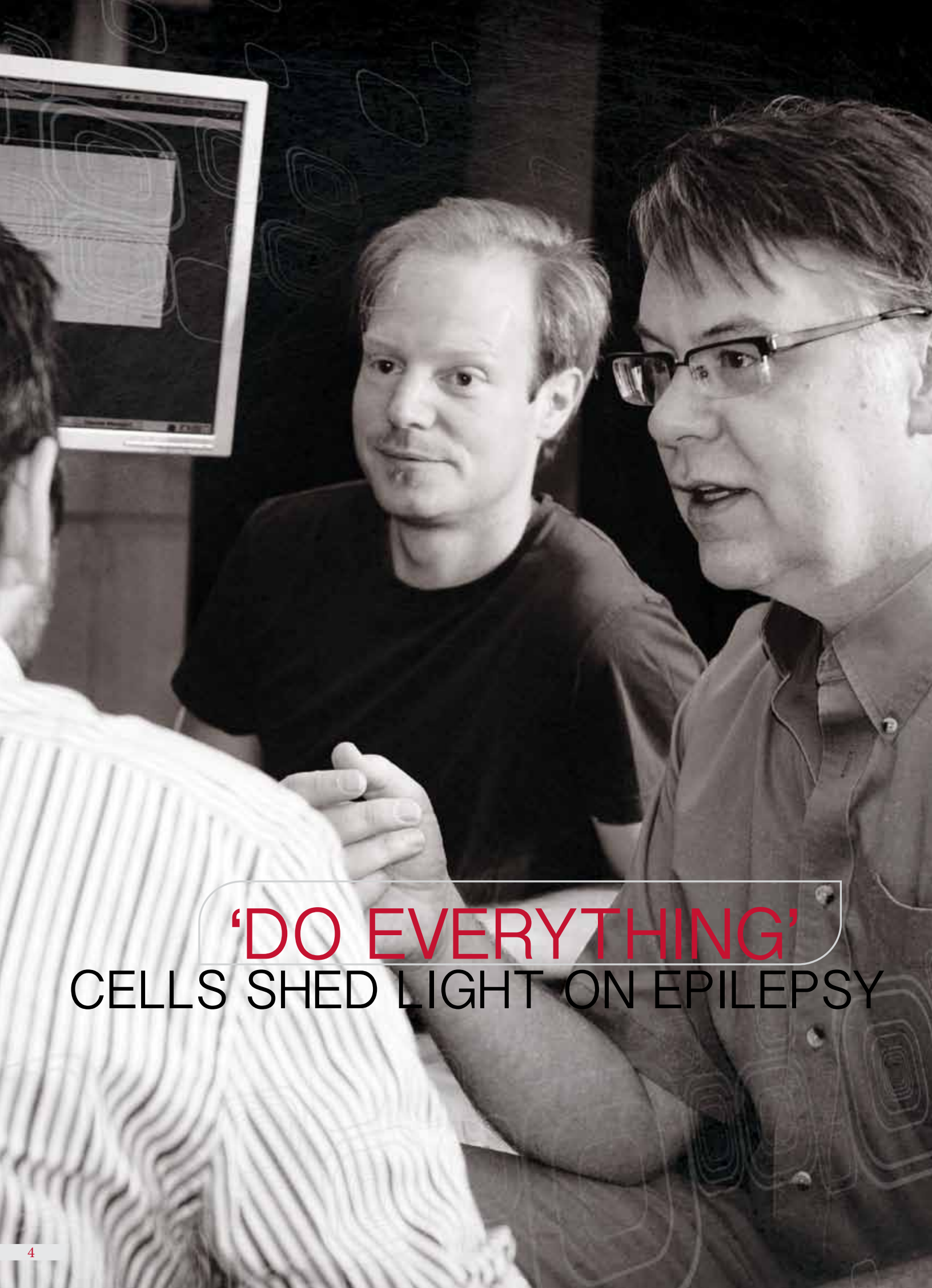
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'DO EVERYTHING'
CELLS SHED LIGHT ON EPILEPSY

Every time an idea ignites in your mind, millions of cells spark in your brain, sending electrical signals through a network to transmit information. For decades, scientists believed excitable cells called neurons were calling the shots. Recent findings, however, suggest silent partners might help neurons with communication in the brain.

“The neurons get all the credit, but there are ten times as many glial cells in the brain,” says John White, Executive Director of the Brain Institute and a USTAR professor of bioengineering and neuroscience at the University of Utah. “These ‘do everything’ cells work behind the scenes to maintain the blood-brain barrier, regulate blood flow, and route blood and oxygen to the part of the brain that needs it the most.”

White and his research group employ engineering approaches to understand how information is processed in the brain. In particular, White’s group measures brain activity using optical and electrical imaging methods to study cells in living tissue. An electrical technique called “patch clamp” probes neurons and glial cells using electrodes to measure electrical signals between cells. A complementary optical technique called two-photon microscopy allows large populations of cells in living tissue to be imaged with high resolution.

Shortly after joining the University of Utah, White struck up a fruitful collaboration with pharmacology and toxicology professor Karen Wilcox and the duo began to consider the underlying causes of epilepsy, a brain disorder resulting in episodes of disturbed brain activity called seizures. Epilepsy affects approximately three million Americans, and for one-third of these patients—a surprisingly large fraction—current drug therapies or devices are ineffective or yield side effects that significantly alter a person’s lifestyle.

“One of the issues we always face in the epileptic brain is that you see large changes in glial cells,” says White. “So the question is, are these changes an attempt on the part of the brain to compensate for seizures and try to calm things down, or are they actually part of the problem? Using our approach, we can image tissue from either the normal or epileptic brain with an unprecedented ability to measure activity in many individual neurons and glial cells at once.”

While cell-gazing, the team also uses a one-of-a-kind virtual reality environment to watch what happens when these workhorse cells are immersed in a network of neurons. This



simulation allows the team to define “rules of engagement” between real and virtual components. Constructing networks that embody characteristics of an epileptic brain, White adds, lends insight on how real cells might function in this environment. “Will the cells behave in the way we expect? Typically, the answer is no.”

“Only a few years ago, it would have been impossible to perform the types of high resolution imaging experiments in epileptic tissue that we can now routinely perform in John’s lab,” says Wilcox. “This allows us to ask important questions about the role of these cells in the generation of seizure activity in the brain. This innovative approach is critical for the understanding of emergent network activity that results in seizures.”

Wilcox and White have received more than \$1 million in funding to date for this work, mainly through the National Institutes of Health. They are part of a larger multidisciplinary research group at the University of Utah studying the mechanisms by which epilepsy arises, including pharmacology and toxicology professor H. Steve White, physiology professor Ed Dudek, pathology professor Robert Fujinami, human genetics research professor Petr Tvrdik, and Nobel Laureate Mario Capecchi.

Rather than studying misfiring neurons, White, Wilcox and colleagues speculate a subset of glial cells called astrocytes play a critical role in epilepsy. If this hypothesis pans out, it could unveil new drug targets for this devastating disorder.

“What’s exciting about this work is that it gives us the opportunity to think about entirely new pharmaceutical agents that no one’s ever thought about before, because they were looking at the problem from an entirely different perspective,” says White. “The most likely positive outcome for human health would be developing classes of drugs designed to go after epilepsy from a completely different approach.”

BIOMECHANICS IN THE BRAIN

Traumatic brain injuries (TBIs) contribute to 50,000 deaths annually and many cases of permanent disability in the United States. Each year, approximately 1.7 million people in the U.S. sustain a TBI, according to the Centers for Disease Control and Prevention. TBI is a contributing factor to approximately one-third of all injury-related deaths in this country.

TBI often results when an object hits a person's head violently, when an object pierces the brain, or when a bomb explodes nearby. Athletes, soldiers and car accident victims are at high risk for TBI. Since mild head injuries may not produce obvious disruption of normal brain function, symptoms of TBI range from mild (headache, dizziness, or blurred vision) to severe (convulsions, seizures, or death). What's more, TBI patients surviving an initial trauma are frequently left with debilitating neurological impairment.

A group of mechanical engineers at the University of Utah is studying the biomechanics of traumatic brain injuries. Although damage to neurons and neuronal connections are the essence of TBI, a patient commonly also sustains injury to blood vessels of the brain. The U researchers focus specifically on this trauma to the blood vessels.

"Nearly all significant traumatic brain injuries include some element of injury to the blood vessels," says Ken Monson, assistant professor of mechanical engineering at the University of Utah. "However, mechanisms and thresholds for vascular damage are not well understood."

Monson and his associates are studying both mechanical loading on blood vessels and also the response of blood vessels to these forces. In a healthy human brain,

the complex structure of blood vessels provides a tightly regulated supply of blood to meet the brain's metabolic demands and to remove waste products from brain cells. The blood-brain barrier formed by the vessels also keeps whole blood isolated from brain tissue.

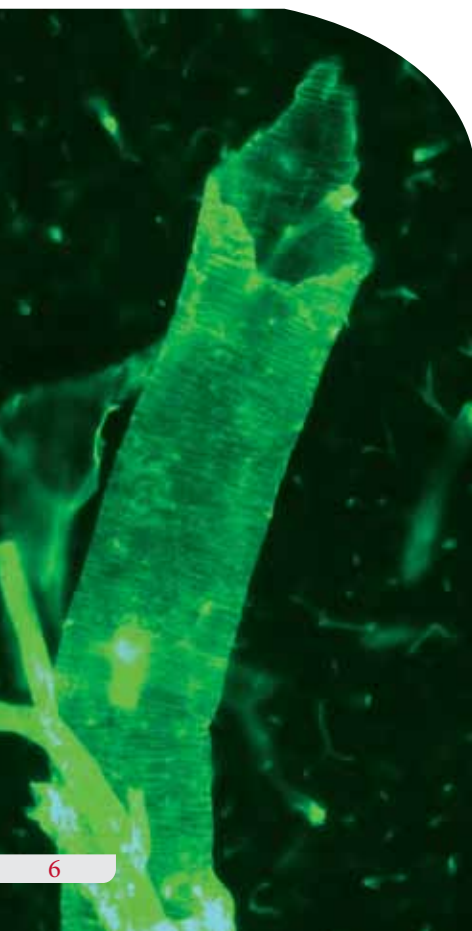
When a TBI occurs, the brain's blood vessels respond in several ways, says Monson. The blood vessels may tear and release blood inside the skull—a structure that cannot easily expand—thereby creating pressure on the brain. Damaged vessels may also release proteins toxic to brain tissue through the dysfunctional blood-brain barrier. Either way, excess pressure may cause brain damage or death, and leaking proteins may kill neurons.

"Cerebral blood vessels sometimes stop functioning properly after a head injury," says Monson. "It's not clear whether loss of cerebral blood flow control occurs because vessels become unresponsive due to mechanical deformation, or whether these vessels are uninjured but are receiving 'bad' signals from their injured environment. We are investigating both mechanisms."

Because Monson cannot study blood vessels in a live human being, he studies isolated vessels in the lab under conditions similar to those of a head injury. "We run tests to address mechanical questions," he says. "What are the material properties? How far can the blood vessel stretch before it fails or becomes unresponsive?"

But testing in the confines of a lab goes only so far in explaining trauma to the brain's blood vessels, says Monson. Monson's group is also developing computational models focused on mechanical interactions between the brain and vessels. One goal is to construct a model at the microscopic level of the brain's cortex. "With a working model, we can show how individual blood vessels are deformed during TBI," says Monson. "The results can then be used to predict injury and its subsequent progression, and could aid in the development of more effective treatments for TBI."

Monson expects these findings to help inform the design of automotive interiors and protective equipment for athletes and soldiers.





Ken Monson / *Mechanical Engineering*

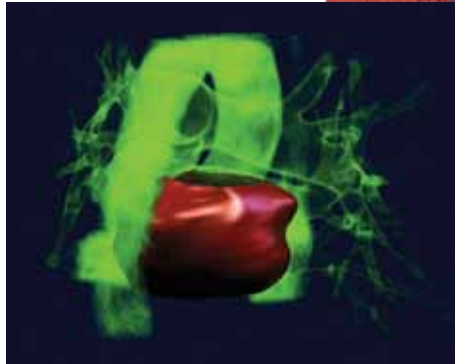
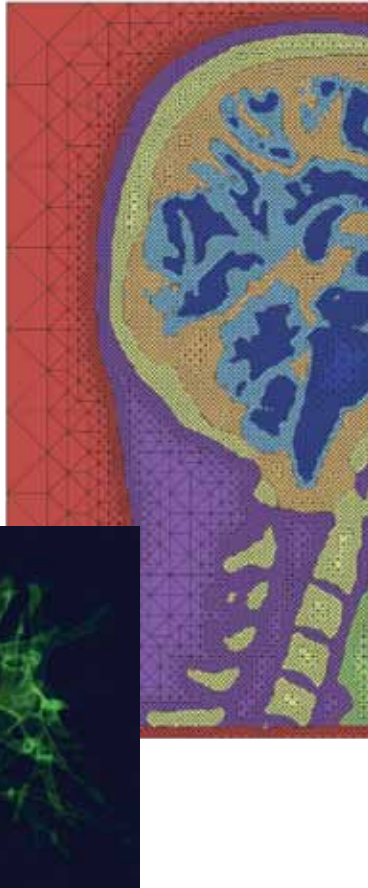
MODELING FOR ALL SHAPES AND SIZES

In our information-driven society, data storage and analysis has become an increasingly cumbersome issue. According to a 2012 report by security software company Symantec, the total amount of information stored by businesses worldwide is now in the zettabyte regime—a unit of information equivalent to one million years of high-definition video. What's more, the amount of time required for analyzing even a tiny subset of this data is well beyond our current capabilities.

Since joining the University of Utah in 2000, computer science professor Ross Whitaker's expertise in unlocking surfaces and shapes to fill two-, three-, or n -dimensional spaces has resulted in models for analyzing images at length scales from atoms and cells, to organisms and even planets. Whether it's a snapshot of silt on the ocean floor or an MRI illuminating the chambers of your heart, Whitaker unspools these vastly different images with a common thread: the geometry of data.

"When you take a photograph, it's really just a collection of color in two dimensions. In medicine or in the oil and gas industries, we have three-dimensional images of anatomy or seismic data," says Whitaker, who is also a faculty member in the university's Scientific Computing and Imaging Institute. "The problem is, people are flooded with images—there are groups in biology generating terabytes of images every six months. Well, a human being can't look at one terabyte of data in six years! So how do you build models of these data and find things people should be paying attention to?"

Whitaker and his team analyze collections of surfaces and shapes in images to model rich details in specific structures, such as electric fields pulsing through the human heart or oil-rich deposits below the ocean floor. What's critical, says Whitaker, is developing a three-dimensional model that not only accurately captures a structure's properties, but also predicts its behavior.



DATA MINING

Whitaker leads a project with Exxon Mobil through University of Utah's Center for Computational Earth Sciences. Geared to probe and efficiently mine elusive oil and gas resources, Whitaker is building a geometric model designed to evaluate seismic signals from the ocean floor.

"By picking up acoustic signals reflected from the bottom of the ocean and all the layers underneath, all these data are pulled together to build a three-dimensional model, rather than being analyzed by hand one layer at a time," says Whitaker. "We have built tools to semi-automatically define shapes of structures that would trap oil and gas deposits."

Using Whitaker's geometric models, for example, geologists can draw parallels between oil-rich pockets and similar structures found nearby. In addition, the simulations based on these models, says Whitaker, can determine whether oil and gas is present, how it got there, and perhaps most crucially, how these resources will behave as these valuable materials are extracted.



Ross Whitaker / *School of Computing*

MODELING IN MEDICINE

“Let’s say you go to the doctor because your arm hurts. One of the things they’ll do is look at your other arm,” says Whitaker. “It’s all a comparison: is this thing unusual, is it different from the other one? Similarly, we study the statistics of ensembles of shapes and identify differences between different groups of shapes. It comes back to what we learned in Sesame Street: one of these things is not like the other.”

Although engineers are extremely comfortable with modeling—“we don’t just build aircraft engines, we predict their properties with computation and simulation,” notes Whitaker—this practice is virtually absent in medical diagnosis and treatment. For simulating physiology from MRI scans, Whitaker and his colleagues generate three-dimensional meshes linking shapes with actual physiology to model human anatomy. The team is currently developing geometric models to help cardiologists study ischemia, a condition in which damaged tissue affects electric field propagation in the heart.

ANALYZING ACCURACY

Starting this fall, Whitaker and a team from the University of Utah, Clemson, Texas A&M and the University of California, Santa Barbara, will launch a project on visualizing uncertainty in simulations for public policy decisions. Funded by the National Science Foundation, this collaboration focuses on computer modeling to inform policy decision makers.

For example, air quality models predict how particulates will affect air quality five to seven years from now based on today’s information. Coupled with weather conditions, these projections will help determine regulatory policies to meet Environmental Protection Agency standards. The problem, says Whitaker, is that these models have inherent errors.

“One of the best ways to understand how something works is to simulate it. However, simulations are not perfect,” says Whitaker. “Whether it’s air quality, wildfires, or hurricanes, if decisions have to be made quickly and the predictive models have errors, how do you display this error in a way that helps someone make a good decision?”

USTAR BUILDING

A NEXUS FOR INNOVATION



USTAR FAST FACTS

The USTAR Initiative is a long-term, state-funded effort to strengthen technological research and stimulate economic development in Utah. This measure allows for strategic investments at the University of Utah to recruit world-class researchers and build state-of-the-art interdisciplinary research and development facilities for first-rate science, innovation and commercialization teams across Utah.

In the first quarter of 2012, USTAR generated 12 new companies, and since its inception in 2007, USTAR has:

- Recruited **35** world-renowned researchers to the U of U
- Filed more than **300** patents and invention disclosures
- Brought more than **\$88 million** in new out-of-state research funding to Utah



The building was designed to meet LEED Gold standards for energy efficiency from the U.S. Green Building Council and is on track for certification. The building sets a high standard for sustainable design by creating an energy efficient building that reduces both energy use and energy cost from current laboratory code requirements by a minimum of 40 percent.

The project was funded through a \$100 million commitment from the state of Utah through its USTAR Initiative, a long-term economic development strategy that has already helped University of Utah recruit 35 USTAR faculty in engineering, medicine, pharmacy, science, business, law and digital media.

A cornerstone \$15 million gift from the Sorenson Legacy Foundation was recognized with naming the building after one of the nation's leading biomedical innovators, James Levoy Sorenson. In addition, generous support was provided from Micron Technology Foundation (\$1.25 million), and private gifts from Dinesh and Kalpana Patel and Jon Huntsman, Sr.

"This facility puts us among a select group of universities with the most advanced tools for cutting-edge research, while providing opportunities to compete for large multidisciplinary federal programs to enhance our visibility," says Richard Brown, dean of the College of Engineering.

Geared to attract some of the most internationally recognized research faculty and fuel Utah's economic development activity, the James L. Sorenson Molecular Biotechnology Building—a USTAR (Utah Science Technology and Research) Innovation Center, was dedicated earlier this year at the University of Utah.

With an emphasis on technology innovation at the intersection of engineering and health sciences, this center promotes interdisciplinary research among teams to support fundamental technologies that fuel the growth of major industries in Utah.

The 208,000-square-foot building features a state-of-the-art nanofabrication facility, with 18,000 square feet of cleanroom space, a biobay, and a 5,300-square-foot microscopy and materials characterization suite. The building also houses the Brain Institute, Nano Institute and Bioengineering Department to foster interaction among researchers.



SHOCK ROCK: SIMULATING SOIL BLAST

Roadside bombs are an ever-present threat for military troops in a theater of war. Despite breakthroughs in intelligence gathering and training techniques for troops, the adaptable nature of improvised explosive devices, or IEDs, presents a unique challenge for protecting military vehicles and personnel from these sometimes crude contraptions.

IEDs have been the leading cause of death in recent years for American soldiers in Iraq and Afghanistan. With the impending withdrawal of U.S. troops from these regions, there is a critical need for a fundamental understanding of soil blasts to help military field personnel detect and mitigate damage from roadside bombs.

As part of a larger effort on soil blast modeling and simulation funded through a \$7.2 million Multi-University Research Initiative (MURI) award from the U.S. Department of Defense's Office of Naval Research, University of Utah's Rebecca Brannon and a team of researchers are developing accurate simulations to analyze the impact of buried landmines and IEDs on light-armored vehicles designed to withstand such blasts.

"The problem is these roadside bombs are being set off in soil and rock, which are materials we really don't know much about," says Brannon, an associate professor of mechanical engineering at the university. "Natural variations in composition and moisture lead to uncertain properties. In the face of this uncertainty, we have to somehow predict how much damage an explosion is going to inflict on a vehicle, its occupants, and its cargo."

Soil lacks a uniform microstructure or large-scale network, complicating efforts to model its response to an explosive. With colleagues Seubpong Leelavanichkul, Biswajit Banerjee, and Jim Guilkey, Brannon is applying a University of Utah-based simulation framework called Uintah, designed to model fluid-structure interactions and investigate how soil fractures and fragments after an explosion.

"You basically have this event horizon—these materials are subjected to loads beyond their breaking point," says Brannon. "The failure initiates at weak points in the material, which produces a release of stress from this point, but since waves move at a finite speed, there's a neighborhood sufficiently far away that continues to suffer the damage from the initial

shock wave because it hasn't yet felt the release wave arrive from distant failure points. So you end up having the sizes of these chunks being determined by how long it takes for the release wave to travel between flaws."

When materials fracture, they have variability in their response. A catastrophic failure such as a soil blast induces stress and extremely large strain in six dimensions—factors not easily handled without undermining a material model's mathematical rigor. Utah's Uintah code, Brannon notes, can help avoid these errors.

"Laboratory investigations are stymied by our own version of a Heisenberg uncertainty: the act of measuring failure properties fundamentally changes the material, so we can't know for sure how it might have responded to a different loading. By trading one form of uncertainty for another, we can re-set a material to a virgin state, allowing us to better understand how statistical perturbations affect strength," says Brannon.

Using a multi-scale, multiphase computational approach called the material point method, Brannon and her team will study how blast waves propagate in soil and what happens when fragments from the explosive device interact with soils of various consistencies, which are affected by natural layering and rainfall.

"Dr. Brannon's expertise in modeling fracture and fragmentation of soils at various densities and moisture contents is critical to providing an efficient, yet rigorous, macroscale computational framework to upscale our computational mesoscale modeling results," says Richard Regueiro, an associate professor of civil, environmental, and architectural engineering at University of Colorado at Boulder who leads the MURI project.

Along with elemental scale laboratory centrifuge experiments involving soils with buried explosives, Regueiro, Brannon and colleagues will develop and validate a model to accurately represent explosive blasts of varying charges, depths and soil types. This requires coordinating experiments and simulations across multiple length scales, a daunting challenge.

"Frankly, no one has successfully probed this phenomenon," says Brannon. "I'm excited to work with this group of people to advance the state-of-the-art in concurrent multi-scale modeling, ultimately to help save lives."



Rebecca Brannon / *Mechanical Engineering*



John McLennan / *Chemical Engineering*

FRAC TO THE FUTURE

A fine-grained sedimentary rock found in the earth's crust, shale holds a significant amount of usable natural gas. With limited access to its hydrocarbon-rich pores, this promising energy supply has languished underground—until recently.

Although shale gas has been produced in the United States for more than a century, industrial-scale shale gas production took off in the U.S. in the late 1980s, when government and private funding for shale extraction technologies culminated in a series of engineering breakthroughs. Innovative technologies such as drilling horizontal wells, microseismic imaging, in-well isolation methods, and hydraulic fracturing provided an affordable key to unlocking shale gas.

Because most shale is not permeable enough to naturally allow significant amounts of fluid to flow to a wellbore, it was not considered to be an economically viable natural gas reservoir. By intentionally injecting fluids into these rocks to propagate cracks, hydraulic fracturing provided a path for natural gas to be released from shale and other geological formations.

“Historically, there have been tens of thousands of hydraulic fractures conducted in the United States, and depending on who you talk to, natural gas is a fuel we are going to be using for the next 20 to 50 years,” says John McLennan, USTAR associate professor of chemical engineering and senior research scientist at the Energy and Geoscience Institute at the University of Utah. “We are exploring hydraulic fracturing from the perspective of sustainability and social responsibility, to help understand what happens when you put highly conductive channels into a low permeability reservoir.”

Shale gas has become an increasingly important source of natural gas in the United States. Indeed, a June 2012 International Energy Agency (IEA) report affirms at current production rates, the U.S. has more than 100 years worth of gas at its disposal, more than half of which is stored in shale and other unconventional rock formations.

A challenge undermining access to low permeability formations such as shales is that it requires pumping large volumes of water and sand at high rates. Only 20 to 40 of every 100 gallons of water used to create a fracture network are recovered once production begins. (One barrel of petroleum holds 42 gallons).

“The argument is, this can’t go on without change,” says McLennan. “With the current price of natural gas in many

parts of the U.S., it costs more to produce the gas than you can sell it for. Beyond the environmental repercussions and stakeholder dissatisfaction with the magnitude of operations that are required, we must return to some level of finesse with these treatments.”

Indeed, environmental activists are concerned hydraulic fracturing could pollute aquifers with fluids or other debris, lead to additional greenhouse gas emissions, or generate earthquakes.

McLennan argues that “while many of these claims are unfounded or overstated, there are opportunities for refinement and there are no short-term, viable alternatives to hydraulically fracturing for natural gas production from shale.”

According to the IEA, these risks can be mitigated through careful construction of wells and monitoring of gas vents and tremors, while adding just seven percent to the cost of a typical shale gas well.

“I’m particularly interested in forecasting where these fractures go—we probably have a lead on the rest of the industry, but the wolves are always at your heels,” says McLennan. “By determining exactly where to carry out fractures and ultimately reduce the amount of water that is used, we can more effectively create these underground networks in an environmentally conscious and economic fashion,” says McLennan.

McLennan collaborates with University of Utah chemical engineering professor and associate dean Milind Deo, who models multi-component, multi-phase flow in fracture networks to understand the morphology and properties of these systems.

“In unconventional oil and gas reservoirs, an understanding of geomechanics is central to creating the necessary surface area and to interpreting the important mechanical changes in reservoirs,” says Deo. “John is an expert in understanding and minimizing the environmental impact of hydraulic fracturing, while also working on creating more efficient fracturing technologies.”

“I’m looking at where we will be in five years,” says McLennan. “The ultimate goal is to be able to wean ourselves from large-volume hydraulic fracturing operations by leveraging thermal, mechanical and chemical considerations for intelligent engineering.”

NEW FACULTY MEMBERS



Amanda Bordelon
Civil Engineering

Ph.D., civil and environmental engineering, University of Illinois at Urbana-Champaign

Fiber-reinforced concrete, fracture mechanics, sustainable materials and pavement design



Zvonimir Rakamaric
school of computing

Ph.D., computer science, University of British Columbia

Practical techniques for improving reliability and correctness of complex systems such as software



Cem Yuksel
School of Computing

Ph.D., computer science, Texas A&M University

Computer graphics from physical-based modeling to real-time and offline rendering techniques



Jamesina Simpson
Electrical and Computer E

Ph.D., electrical engineering, computer science, Northwestern University

Computational electromagnetics theory and applications



Jeff Phillips
school of computing

Ph.D., computer science, Duke University

algorithms for large-scale data analytics at the intersection of data mining, computational geometry, and algorithms for big data



Jur van den Berg
school of computing

Ph.D., computer science, Utrecht University

robotics, virtual environments

Shelley Minter

materials science and engineering

Ph.D., chemistry, University of Iowa

electrochemical energy conversion devices: enzymatic biobatteries and biofuel cells



Miriah Meyer

school of computing

Ph.D., computer science, University of Utah

design and development of interactive visualization tools to explore complex, scientific data



Shad Roundy

mechanical engineering

Ph.D., mechanical engineering, University of California, Berkeley

methods to harvest and store energy for wireless and MEMS inertial sensors



Feifei Li

school of computing

Ph.D., computer science, Boston University

large scale data management, probabilistic data, security and privacy issues in data management



Andrew Merryweather

mechanical engineering

Ph.D., mechanical engineering, University of Utah

biomechanical/biomedical design, ergonomics, rehabilitation engineering and human-centered movement analysis



Jeff Walling

electrical and computer engineering

Ph.D., electrical engineering, University of Washington

high efficiency radio architectures for low power wireless sensors and software-defined radio



Jacobus van der Merwe

school of computing

Ph.D., computer science, University of Cambridge

networking systems research, mobile networking, network evolution and security, and cloud computing



BY THE NUMBERS

The University of Utah's College of Engineering is among the top 40 U.S. engineering schools* in undergraduate and graduate degrees awarded in 2011. The College is among the top 50 U.S. engineering schools* in enrollment:

#26 in computer science (of 167 total)

#47 in undergraduate enrollment (of 343 total)

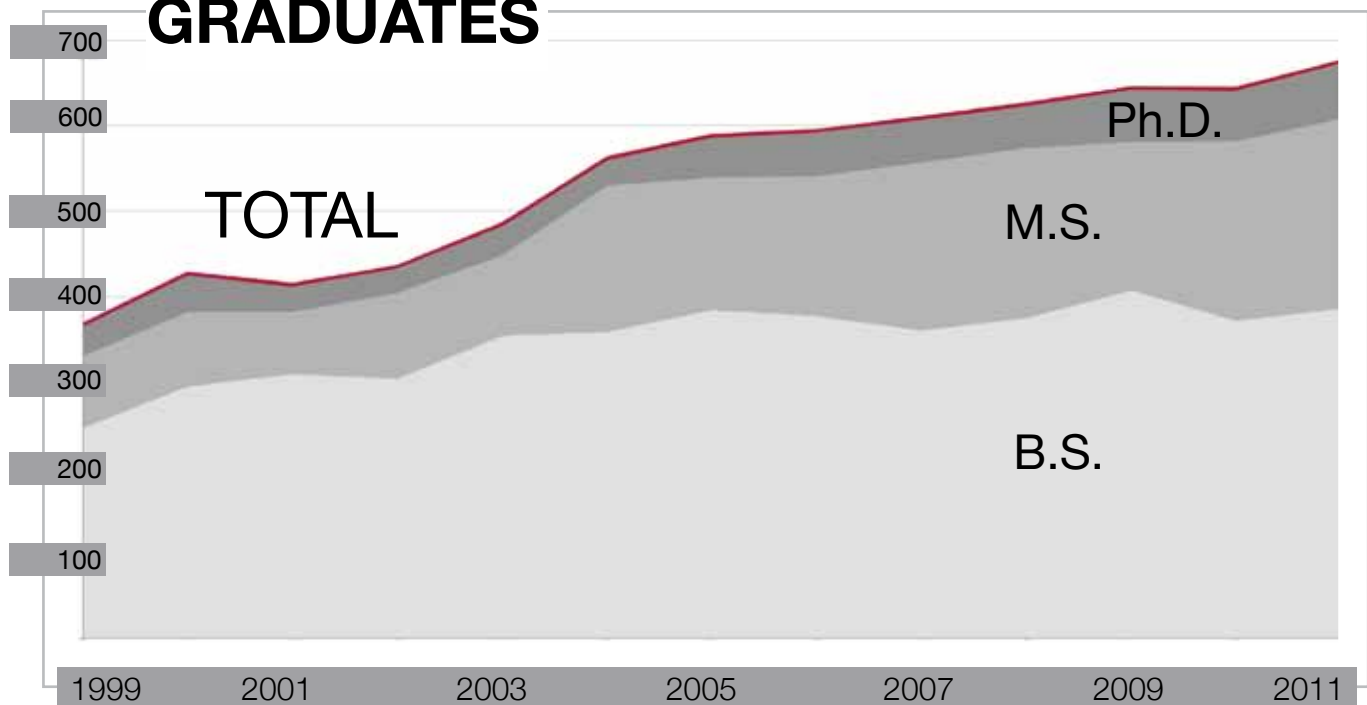
#39 in mechanical engineering (of 113 total)

#48 in graduate enrollment (of 266 total)

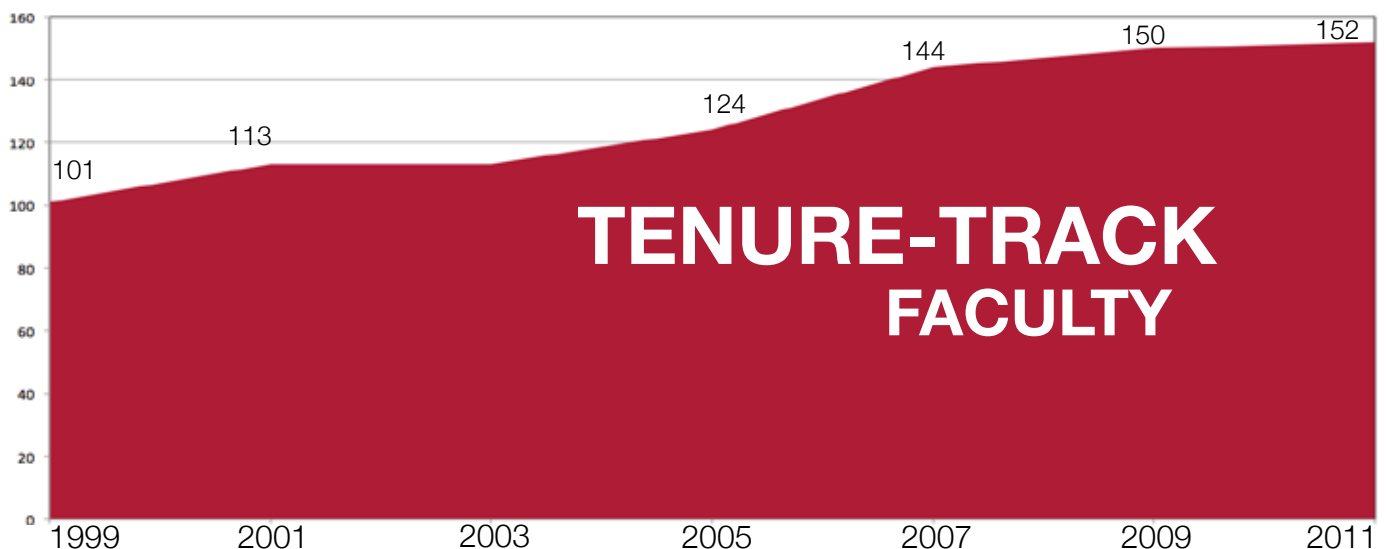
#37 in doctoral degrees (of 196 total)

*Statistics from Profiles of Engineering and Engineering Technology Colleges, American Society of Engineering Education (2012).

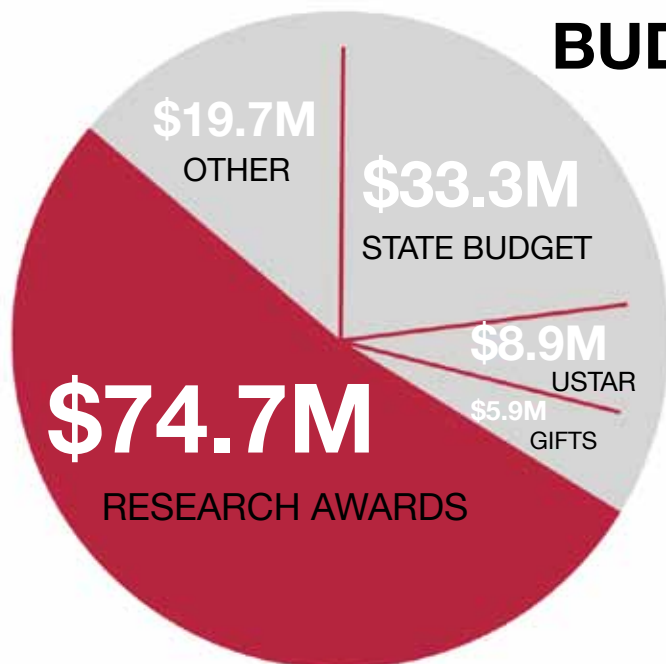
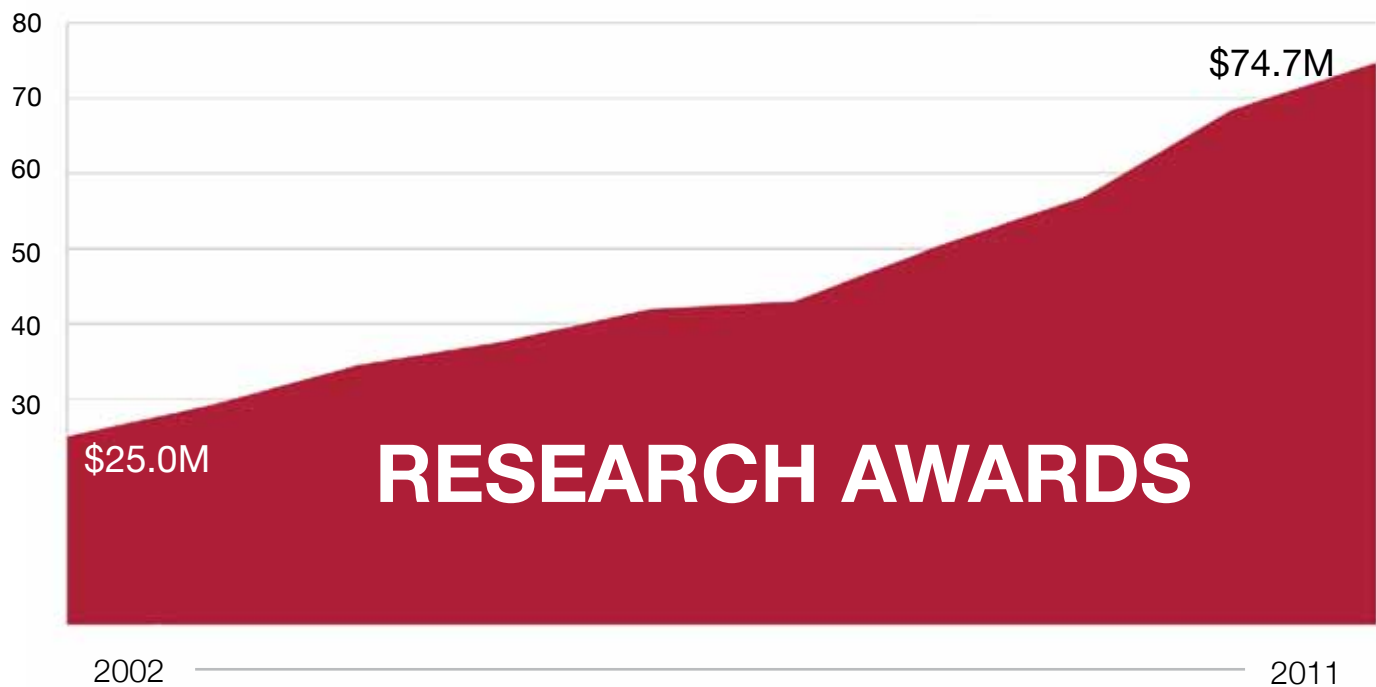
GRADUATES



The College is **#32** in the number of tenure-track faculty (of 346 total) in 2011.

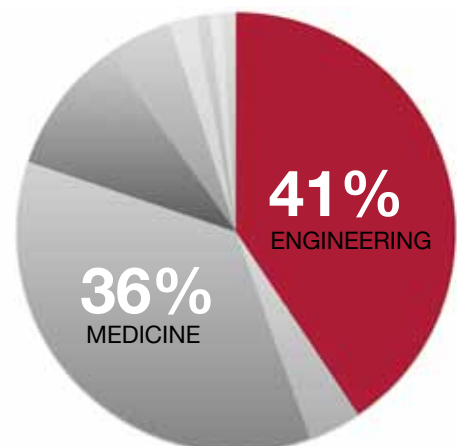


The College ranked in the top 100 programs in the Academic Ranking of World Universities. Developed by Shanghai Jiao Tong University, these respected university rankings weigh publication citations, faculty and alumni awards, and other academic and research performance metrics. For 2011, the University of Utah's rankings are: **#79** overall, **#51 – 75** in Computer Science, and **#76 – 100** in Engineering and Computer Science.



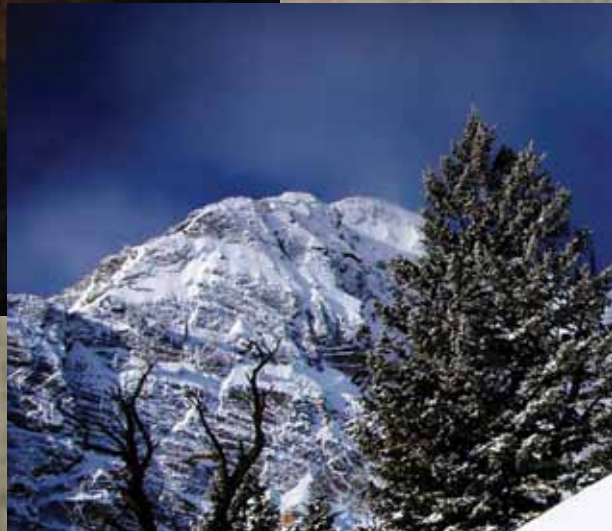
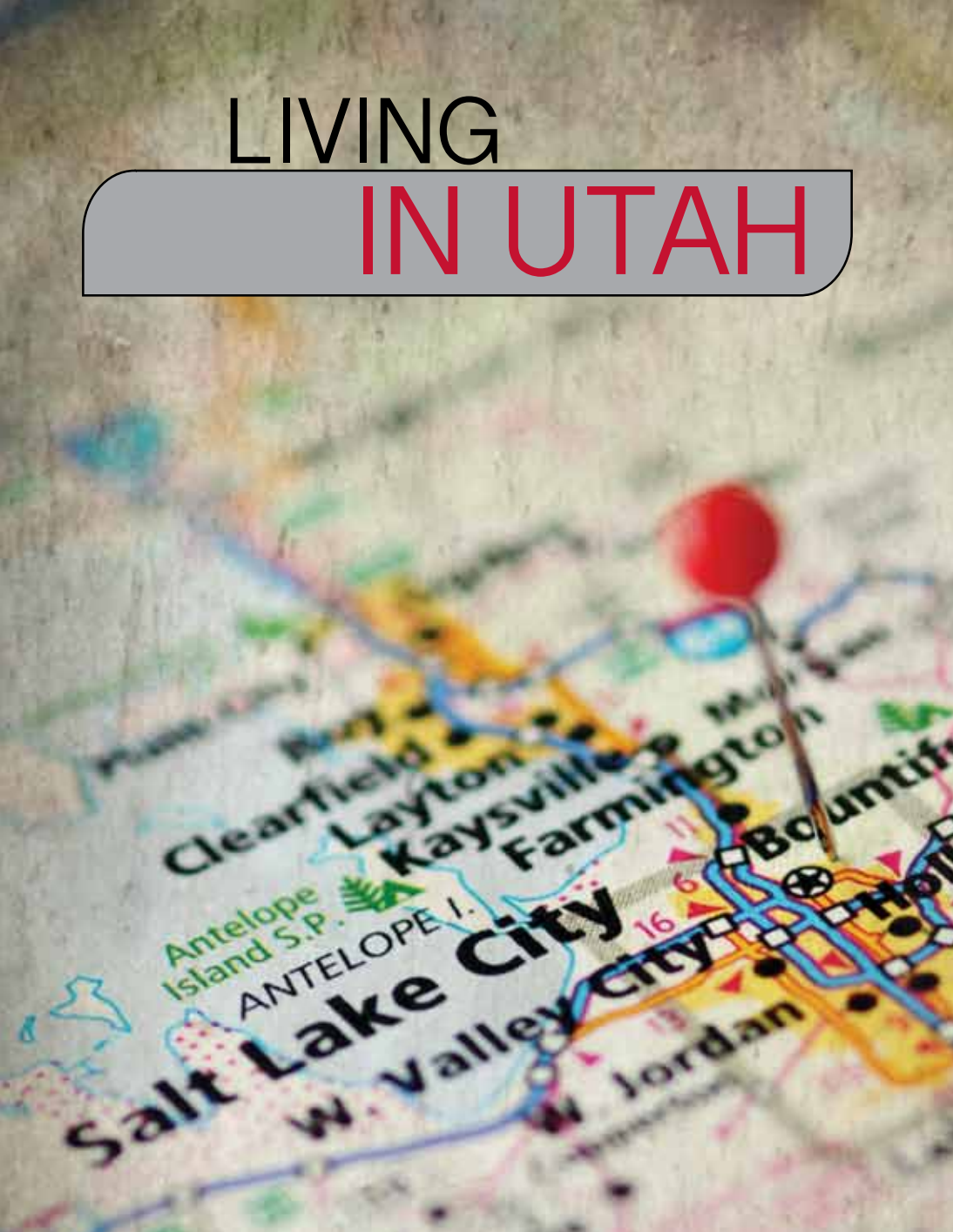
For the second year in a row, the University of Utah was **#1** in launching startup companies from university research, based on rankings from the Association of University Technology Managers. Researchers have successfully commercialized intellectual property through the university's Technology Commercialization Office, which focuses on economic development in the state of Utah. Since 2005, 41% of spin-off companies stemming from university research have been from the College of Engineering.

COMPANIES LAUNCHED



LIVING

IN UTAH



UTAH'S ECONOMIC PROWESS

Utah continues to live up to its billing as the most dynamic economy in the United States, and as the state best-positioned to weather and recover from an economic downturn.

In 2011, *Forbes* listed Utah as the **“Best U.S. State for Business and Careers,”** and *Newsweek* named Salt Lake Valley one of ten “Places in America” poised for economic recovery, describing the region as a “new Silicon Valley” combining high-paying technology jobs with low living costs.

Salt Lake City's workforce ranked **#1** in the U.S. for productivity in 2011, according to the Brookings Institution's Metropolitan Policy Program.

For the second year in a row, the University of Utah ranked **#1** in the number of start-ups developed by faculty at a U.S. university.

Building on our existing economic momentum, Utah ranks high across job growth, business creation, and educational metrics. In 2012, the U.S. Chamber of Commerce ranked Utah:

- #2** in export growth, business birth rate and as a future boom state
- #3** in short and long-term job growth, higher-education efficiency, entrepreneurship and innovation
- #4** in science, technology, engineering and mathematics (STEM) job growth
- #6** in cost of living and college affordability
- #10** in higher-education degree output



photo courtesy of Todd McKinley



ENGINEERING A MULTI-DISCIPLINARY WORLD

Home to seven academic departments and 16 research centers and institutes with crosscutting themes in energy, scientific computing, and next-generation materials, University of Utah's College of Engineering is poised to address some of our country's most critical engineering challenges.

Bioengineering

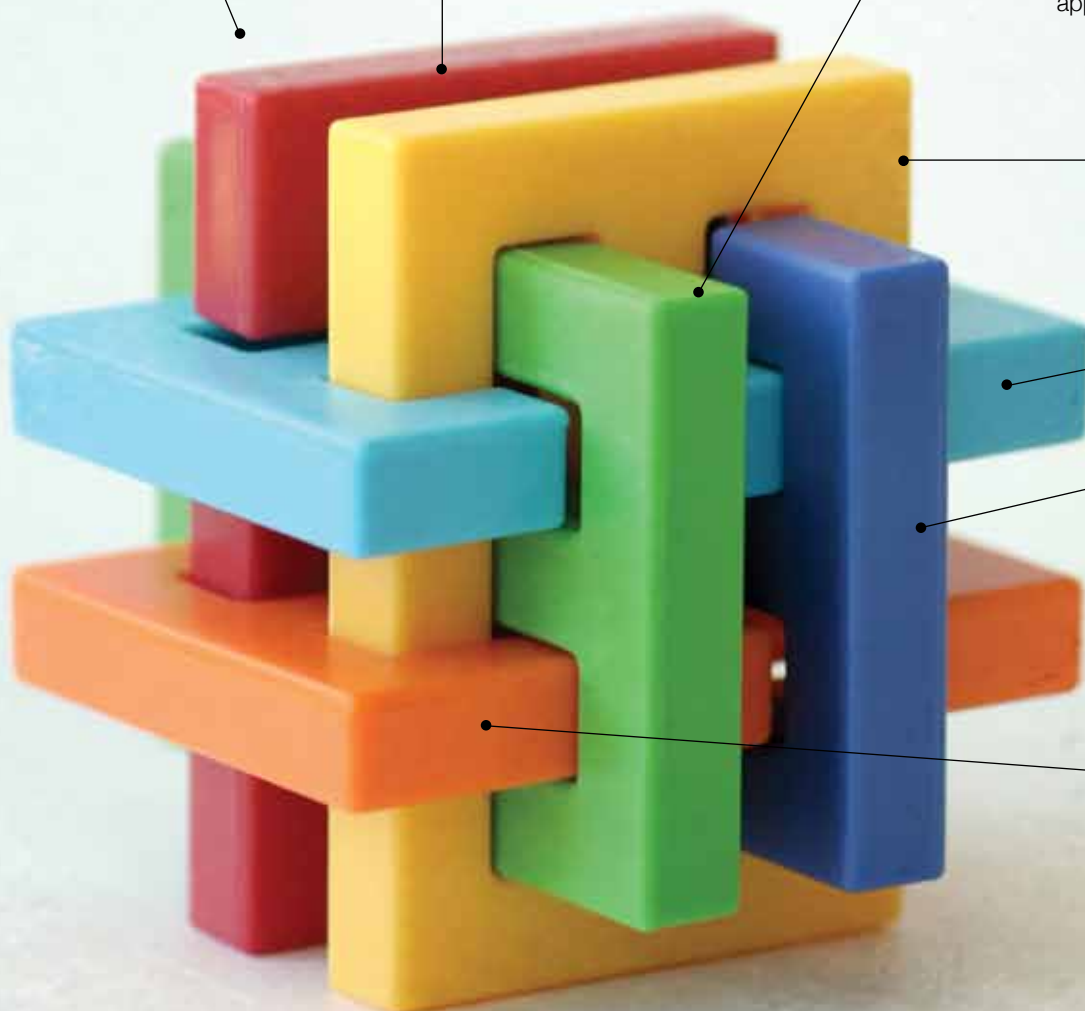
From biologically-inspired engineering to mathematical medicine, expertise in this department includes neural and cardiovascular engineering, biomedical imaging, molecular, cell and tissue therapeutics, and bio-design.

Chemical Engineering

Spanning length scales from molecular to large, industrial processes, this department specializes in energy and fuels, multi-scale simulation, reaction engineering, rheology, nanomaterials, nuclear engineering, biomedical devices, systems and controls.

Materials Science and Engineering

Connecting a material's atomic or molecular structure with its macroscale properties, this department investigates nanomaterials, semiconductors, electronic materials, biomaterials, ceramics and composites, along with computational methods, for engineering applications.



Civil and Environmental Engineering

Providing innovative solutions to design, construct and maintain society's infrastructure, this department emphasizes environmental engineering, geotechnical and construction materials, structural engineering, transportation, water resources and engineering management.

Nuclear Engineering Program

Innovating for 21st century nuclear engineering education, this program accentuates nuclear reactor modeling and benchmarking, nuclear material detection, nuclear medicine, robust computational methods, and radiation shielding analysis for space missions.

Mechanical Engineering

Leveraging energy, forces, fluids and materials to design reliable, environmentally sound and cost-effective devices, expertise in this department includes ergonomics, robotics, mechatronics, solid mechanics, thermal fluids and energy systems.

Electrical and Computer Engineering

Building electronic devices for communication, productivity and entertainment, this department's proficiency lies in communications, image and signal processing, optoelectronics, microwaves and electromagnetics, device fabrication, control systems and power engineering.

School of Computing

Blending theory and practice in the study of computing, this department's areas of focus include scientific computing and visualization, artificial intelligence, data science, information management and digital media.

Entertainment Arts and Engineering Program

A unique joint effort between the School of Computing and the Department of Film and Media Arts, this program offers a one-of-a-kind advanced degree in game production and interactive entertainment.

Computer Engineering Program

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

MULTIDISCIPLINARY RESEARCH INSTITUTES AND CENTERS

Energy and Geoscience Institute
Scientific Computing and Imaging Institute
Institute for Clean and Secure Energy
Materials Research, Science and Engineering Center (MRSEC)
Nano Institute
Center for High Performance Computing
Brain Institute
NIH/NCRR Center for Integrative Biomedical Computing
NVIDIA CUDA Center of Excellence
Nora Eccles Harrison Cardiovascular Research and Training Institute
Center for Controlled Chemical Delivery
Center for Parallel Computing at Utah
Visualization and Analytics Center for Enabling Technologies
Utah Center for Neuroimage Analysis
Rocky Mountain Center for Occupational and Environmental Health
Utah Center for Advanced Imaging Research
Center for Computational Earth Sciences

TED JACOBSEN

Each year, the College of Engineering presents the Distinguished Service Award to an individual who has given extraordinary service to engineering education. This year's honoree is Ted Jacobsen, Chair of the Engineering National Advisory Council.

After graduating from the U in 1965 with a B.S. in civil engineering and receiving a M.S. from Stanford, Ted joined Jacobsen Construction, founded by his grandfather. From 1974 to 1996, Ted served as the company's president, followed by nine years as board chairman.

Ted also served as president of Associated General Contractors of Utah and was awarded their prestigious Eric W. Ryberg Award in 2002 for outstanding service to Utah's construction industry.

As a leader in the construction industry, Ted directed the construction of the Warnock Engineering Building. The college will award a scholarship in Ted's name this fall to a student who has demonstrated distinguished service.

ENAC

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Managing Principal, Deloitte

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Frank Associates

Kim Worsencroft

Technology Entrepreneur

*Retired



SYNTHETIC FUELS
HYDROCARBON
EXPLORATION
MACROMOLECULAR
BIO-MECHANICAL
ROBOTICS

MIMO/CDMA DETECTION MATERIALS



DISCOVER

IMPLANTABLE DEVICES
NANOPHOTONICS
SEMICONDUCTORS
ELECTROMAGNETICS
EMBEDDED SYSTEMS
WATER RESOURCES
TRANSPORTATION
VLSI SYSTEM DESIGN
NANOTECHNOLOGIES
SCIENTIFIC COMPUTING
POWER ENGINEERING
BIOMEDICAL DEVICES
PHOTOBIOREACTORS
ELECTRICAL SYSTEMS

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