THE UNIVERSITY OF UTAH COLLEGE OF ENGINEERING

2013 RESEARCH REPORT

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FROM THE DEAN

What do the health effects of retreated wastewater, high-speed computer network security and the regeneration of torn ligaments following a knee injury have in common? They are part of the rich diversity of engineering research at the University of Utah highlighted in this year's research report. They also represent the scope of quality-of-life issues being addressed by our engineering faculty. With $81.5M in research expenditures, the College ranked 30th out of 206 schools in research productivity in the 2012 ASEE Profiles, which compares U.S. engineering and technology programs.

For students at Utah's flagship university, this research-intensive environment provides a wealth of opportunities to engage with faculty working at the leading edge of technological innovation. As a result, more and more students are choosing the University of Utah for their graduate education.

In the past 10 years, the College has more than doubled its output of masters and doctoral degrees. The ASEE report ranks Utah 34th out of 196 schools in the number of engineering and computer science doctoral degrees. Attracting students and faculty alike is a dynamic environment in which large multi-disciplinary research projects flourish, with robust collaboration among the Colleges of Engineering, Science, Mines and Earth Sciences, Pharmacy and Medicine. This capacity for successful collaboration is attracting national attention and significant federal dollars.

A $12M National Science Foundation grant in 2011 established a new Material Research Science and Engineering Center. In June 2013, the college was named a National Nuclear Security Administration (NNSA) multidisciplinary center of excellence. This $16M effort is funded by NNSA's Predictive Science Academic Alliance Program II. Overall, research awards constitute more than half of the College's $129.6M budget.

Research also enhances the undergraduate experience: nearly 25% of all undergraduate research assistantships awarded each semester are given to students in the College of Engineering. These students put classroom theory to work on real-world problems. Learning is enhanced by faculty members who bring the excitement of discovery from the lab into the classroom.

As you read this year's research report, I hope you will share in some of our excitement. Whether it's designing the next-generation computer chip, optimizing the process of deep earth fracturing for oil and gas recovery, or developing a computer game that can help kids fight cancer during treatment, engineering faculty at the University of Utah are extending the boundaries of knowledge while preparing the next generation of technology leaders and innovators.

Richard B. Brown
DEAN, COLLEGE OF ENGINEERING

IN THIS ISSUE

Robert Kessler / *School of Computing*

TOP OF THE CHARTS

After receiving #1 and #2 rankings for its undergraduate and graduate game degrees from Princeton Review in March 2013, it's been a banner year for the University of Utah's Entertainment Arts and Engineering (EAE) program.

A unique interdisciplinary effort between the U's College of Engineering and College of Fine Arts, EAE offers unique degrees in video game design, production and interactive entertainment. Earlier this spring, the Utah State Board of Regents approved an EAE master's degree at the University of Utah, the first advanced degree for EAE in Utah.

The popularity of the EAE program continues to grow. Nearly one-quarter of all computer science and film and media arts undergraduates at the U are in the program, while the number of graduate students has grown from 19 to 90 students since it started in 2010. This year's batch of students is the largest incoming graduate class to date.

"There are some people who last a really long time in the games industry, and others who do it for five to ten years and then want to go do something else. Students leave our program with a computer science degree but take their electives in games," said Bob Kessler, director of the EAE program and professor of computer science at the U. "From an engineering perspective, we are doing what I believe is exactly the right thing: at the undergraduate level, it's a mistake to have some kind of a limited video game degree. Our degree gives students tremendous flexibility in their careers, whether they stay in games or move on to other arenas."

The video game industry continues to skyrocket, but in recent years, gamer demographics have changed dramatically. A 2013 report by the Entertainment Software Association revealed more women aged 18 or older play video games than boys under 17. "Ninety-nine percent of boys and 94 percent of girls play video games regularly, which is mind-boggling. It's not just teenage boys in a dark basement anymore," noted Kessler.

What's more, games have become an integral component of family recreation in the United States: 71 percent of parents say playing video games provides mental stimulation or educational value for their children, and 52 percent of parents say video games are a positive part of their child's life.

Games aren't just for entertainment, however. Functional nuclear magnetic resonance imaging studies suggest reward centers in the brain show activity, or light up, when playing games. Researchers at the U are capitalizing on this behavior to create games that help people in their everyday lives and careers. These findings, Kessler says, can be used for "serious games" in education, medicine or even military training. "Because it's interactive, you will retain information better or learn to do something that actually sticks in your mind, as opposed to being taught passively."

In collaboration with School of Computing faculty member John Hollerbach and Utah-based spinal cord and neurology recovery center NeuroWorx, Kessler is developing a rehabilitation game for patients with spinal cord injuries. The team has developed a suspended treadmill system, called a treadport, with projection walls surrounding it that immerse a patient in a different world while they perform their physical therapy. For example, the immersion environment could be an open grassy area with animated characters to chase around. The idea, says Kessler, is to keep patients engaged in physical therapy so they recover faster.

Kessler is also working with colleagues in the U's College of Engineering and School of Medicine to develop games for training medical personnel that use robotic laser ablation to minimize arrhythmia in the heart and manually harvest veins for bypass surgeries. These research collaborations also provide internship opportunities for graduate students to conduct research and gain more experience before entering the workforce. "We are giving our students an internship to work on something fascinating and we are getting research done—it's the best of both worlds."

MARKETPLACE NETWORKING

Whether it's dragging data speeds or spotty service, nearly everyone has experienced problems with their network provider. With an ever-increasing demand for what smartphones and tablet devices are expected to do, it's no surprise current network infrastructures are being stretched to their limits.

"If you look at how cellphones have evolved just in the last 10 years, what you are essentially carrying around is a small computer—the amount of stuff you can do is amazing. But if you look at the underlying architectures, it really still looks like 20 years ago," said Kobus Van der Merwe, an associate professor in the School of Computing. "For smartphones in particular, it's pretty clear that at some point, the current mobile network architecture is going to break."

After an illustrious career at AT&T Research Labs in New Jersey, Van der Merwe joined the University of Utah in 2012 as the Jay Lepreau Professor in the School of Computing and director of the Flux Research Group.

"Today, the way you get your Internet through AT&T or Comcast, what they provide is what you get, end of story," said Van der Merwe. "With an open-access network, the infrastructure is built by a community or municipality. This makes it more like an amenity in which you have access to a basic network that's connected to or is part of your house, but other service providers come and offer services on top."

By researching techniques to automate network management, Van der Merwe and his collaborators hope to remove the human component of service providers and improve performance. Rather than having to call your service provider when your Internet connection slows down, a provider might use a network management app that detects the problem before it deteriorates and attempts to fix it automatically. What's more, Van der Merwe says, this "open-access marketplace model" makes it a lot easier for independent providers to offer services.

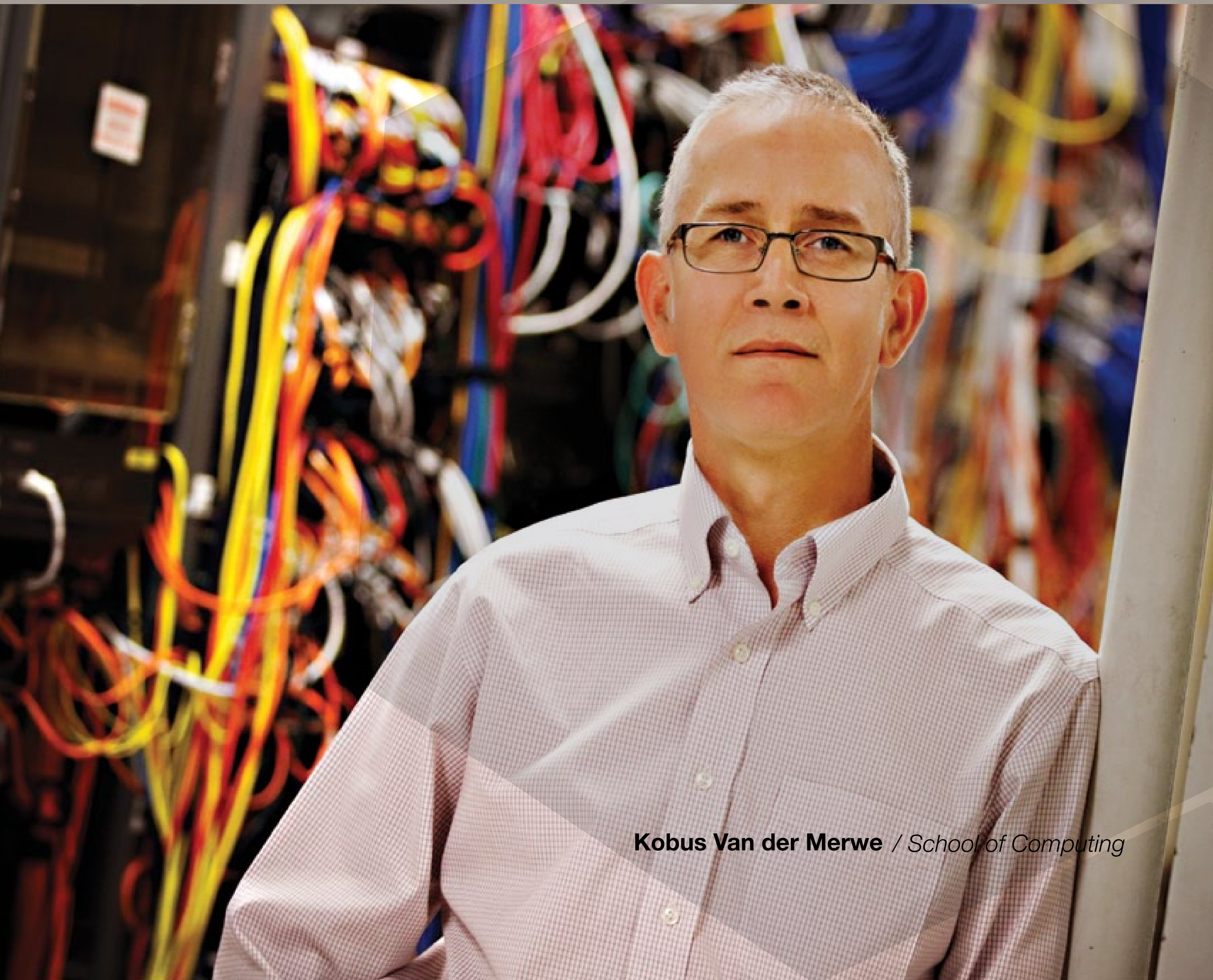
"With an app or marketplace model, if you have an idea for a service and can provide the service easily, the process of becoming a service provider is dead easy," Van der Merwe says. "If it works, you start making money, if it doesn't, it goes away. Today, you have to come up with a business plan and put some money on the table. If you make it really easy and allow others to build on that infrastructure, you open the door for innovation."

In addition, Van der Merwe is exploring the role of cloud computing in the future of networking. Leveraging shared computing resources through the Internet instead of storing programs and data on local servers or personal devices, cloud computing connects networks of servers to spread data-processing chores across large pools of linked computer systems.

The cloud offers vastly more capacity and flexibility to businesses and everyday consumers. Cloud computing is especially powerful for data storage (e.g., financial and medical records), or to power immersive video games connecting multiple players.

"Cloud computing works because it's a shared infrastructure," said Van der Merwe. "But that's exactly the weak spot from a security perspective—in a cloud environment, resources are shared between clients, which means if someone has malicious intent, they can exploit this sharing model."

Attackers typically probe cloud infrastructures to sniff out how virtual machines and IP addresses are allocated within the system before mounting an attack. Currently, cloud security is addressed only after an attack; Van der Merwe and other researchers are studying how to manage security in the pre-attack stage before intruders go too far.



Kobus Van der Merwe / *School of Computing*

By deploying a honeypot—a decoy set up explicitly to be attacked—an attacker can be misguided into thinking he or she has gained access to a system. "The more sophisticated ones string the attacker along," said Van der Merwe. "You want to learn what they do: it's like 'OK, I'll let you log in, and pretend you guessed the password correctly, and see what you do next.'"

"The cloud isn't going away—the economics makes sense and it's a very attractive model, but security is a big concern," said Van der Merwe. "Given this, we are trying to understand what happens if you add noise to the system: make the cloud infrastructure intentionally look different from what it really is, so if you are poking around just to see what the structure is, you won't be able to tell."

Otakuye Conroy-Ben / *Civil & Environmental Engineering*

DRUGS IN THE WATER

Found in everything from laundry detergent to a can of soup, a class of hormone-altering chemicals causing adverse health effects in humans and animals are of growing concern to researchers and the general public alike.

These chemicals, called endocrine disruptors, interfere with signals in the body that regulate hormones. By turning these signals on or off, or by modifying their behavior, endocrine disruptors can affect the normal function of our tissues and organs, leading to problems in development, reproduction and metabolism.

Endocrine disruptors are ubiquitous in our daily lives. In addition to hormones we produce ourselves, such as estrogen, androgen, or thyroid hormone, endocrine disruptors can be found in certain plastics, canned food liners, medicines and pesticides.

Bisphenol-A (BPA), a widely used plastic additive, has received a great deal of attention due to its potential effects on the development of fetuses and young children. In 2012, the United States Food and Drug Administration banned the use of BPA in baby bottles.

To help understand the wider effects of endocrine disruption, University of Utah engineering faculty member Otakuye Conroy-Ben is leading an effort to investigate what happens to these contaminants when they leave our bodies and enter the environment.

“Despite major studies on the breakdown of these endocrine disruptors, it’s difficult to pinpoint why these chemicals persist as they make their way through the sewer system and into wastewater treatment plants,” said Conroy-Ben, an assistant professor of civil and environmental engineering at the U.

“Because treatment plants cannot break down these chemicals, they get back into the water cycle. In some areas, these chemicals end up making their way back into the drinking water system.”

Understanding the impact of endocrine disruptors on public health is complicated: people are typically exposed to multiple endocrine disruptors simultaneously through their diets as well as what they drink, touch and breathe. In addition, there are currently no established regulations on what level of exposure to endocrine disruptors is deemed safe.

Previous research studies on laboratory animals and wildlife show endocrine disruptors can mimic estrogen—the female sex hormone—and cause their reproductive systems to go haywire. This results in reduced male fertility and abnormalities in male reproductive organs. Researchers are discovering a slew of aquatic animals turning female after exposure to human female hormones.

“These chemicals may be of significant concern but because they are not yet regulated by the Environmental Protection Agency, utilities won’t treat the wastewater until they have to,” said Conroy-Ben. “Researchers at universities can contribute a great deal to understanding the biological activity of these chemicals in wastewater and help guide regulatory action.”

Conroy-Ben and colleagues are also studying other chemicals in the Salt Lake Valley entering our wastewater, including antibiotics, pharmaceuticals—and illegal drugs.

By collecting wastewater from the major wastewater treatment facility in the Salt Lake Valley and measuring the constituent chemicals, the group analyzed drug use from nearly one million people in the valley.

“We were able to track down which areas use the most methamphetamines, cocaine, marijuana and caffeine,” said Conroy-Ben. “You wouldn’t think certain areas of the valley used more drugs than other areas, but they do. Also, we found a very high signature of caffeine from all areas of Salt Lake City and surrounding suburbs.”

Jeff Weiss / *Bioengineering*

MODEL MECHANICS

In recent years, research at the intersection of engineering and medicine has produced breakthroughs in diagnosis, therapy and rehabilitation. Although the human body is far more complex than a machine, insights into unraveling the mechanisms of human biology have helped improve our health and quality of life.

At the University of Utah, bioengineer Jeff Weiss couples experimental and computational techniques to tackle problems in musculoskeletal science. Among myriad contributions to biomechanics research, his group has shed light on the role of tissue geometry and mechanics and their impact on both injury and repair.

In 2003, Weiss developed FEBio, a finite element analysis software suite to model mechanical and physical properties in biological systems. After optimizing this software in-house, Weiss began sharing the package with other researchers in the community.

"We realized early on that most of the people in our research space were limited by the software they were using," said Weiss, professor of bioengineering at the University of Utah. "It wasn't helping that the software available at the time was proprietary, which made sharing models—not to mention results—incredibly difficult."

Before FEBio, Weiss says, most finite element analysis software packages were commercially designed for the aerospace or auto industry, and weren't applicable to problems in biomechanics. What's more, these packages came with corresponding licensing fees of tens of thousands of dollars per year. In comparison, FEBio is freely available to academic researchers through the University of Utah's software licensing agreement.

Since 2007, Weiss and FEBio have received steady funding from the National Institutes of Health to distribute the suite to the broader biomechanics and biophysics community. In the last seven years, FEBio has been downloaded more than 50,000 times and cited in nearly 150 research papers; Weiss now has two full-time staff supporting hundreds of users on development forums and tutorials.

"I've been involved with basic and applied research in bioengineering for 20 years, but I think this software has had more impact and visibility for my laboratory than even my most-cited scientific papers—the response is just amazing," said Weiss.

In an ongoing collaboration with University of Utah orthopedic surgeon Chris Peters, Weiss is building models to understand hip dysplasia, a bony abnormality in the hip socket that could trigger osteoarthritis. Researchers have proposed that contact stresses in the hip may lead to arthritis at an early age.

"Correcting unusual contact stress distributions in the joint requires fairly invasive surgeries," said Weiss. "Now we can provide surgeons with 3-D models of the stresses to plan clinical treatment. If we can help point out patients who aren't good candidates for invasive surgery and would be better treated conservatively, this is a better overall outcome for the patient."

Working with Peters to obtain volumetric x-ray computed tomography images of each patient's hip, Weiss built computer models specific to each hip joint. These models can help guide the diagnosis and surgical planning or alternative treatment strategies for a given patient. In addition, Weiss' simulations of normal and dysplastic hips show how load is distributed in these joints, which is where degeneration—and arthritis—begin.

"It turns out osteoarthritis is a developmental disorder: if you do certain activities when you are a teenager, it tends to act up later in life," said Weiss. "This means a football player or a weightlifter has more of a propensity to develop these issues. The cool thing about this project is that it is a perfect application of mechanics—a mechanical problem with mechanical interpretation."

UNCONVENTION

According to the International Energy Agency, the United States will be the top producer of oil in the world by 2020, surpassing oil stalwarts Saudi Arabia and Russia. This path toward energy independence is being fueled by a dramatic increase in production of unconventional oil sources: methods used to produce or extract petroleum apart from traditional oil wells.

Extracting light crude oil from shale rock was long considered unproductive due to low permeability. More recently, these resources have been unlocked with the advent of hydraulic fracturing, or fracking. By injecting fluids into an oil source to propagate cracks, hydraulic fracturing allows oil and gas to be released from shale and other geological formations.

"The U.S. energy picture is changing quite rapidly," said Milind Deo, professor and chair of chemical engineering at the University of Utah. "Oil and gas production is skyrocketing due to unconventionals—in just three years we've reached one million barrels of oil per day from shales. This growth requires understanding of what responsible development really means. One of our objectives is to retrain engineers who are not experts in petroleum engineering and give them the background needed to practice in this field."

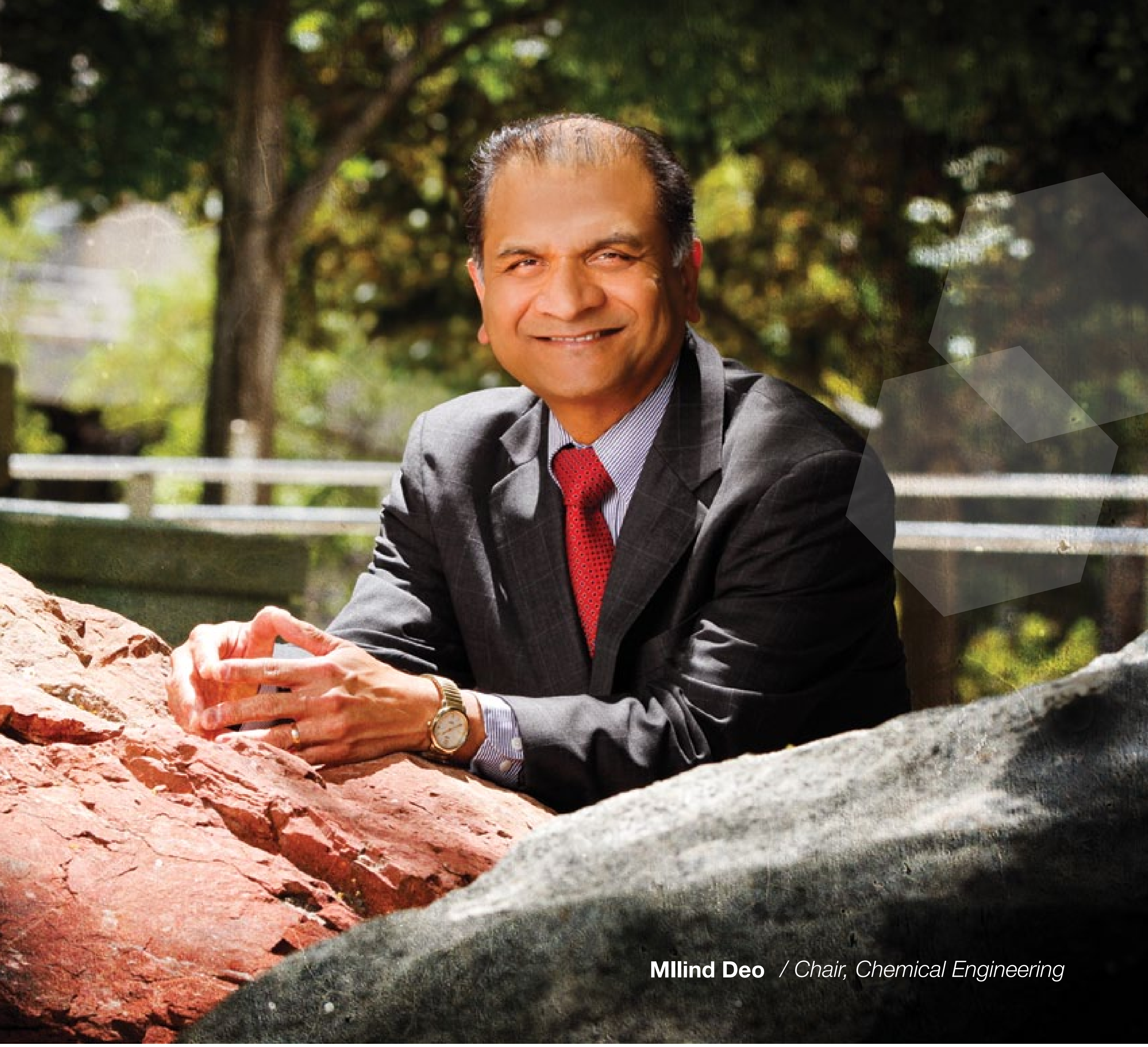
This meteoric rise in unconventional fuel production comes with a parallel demand for experienced employees. U.S. Department of Labor statistics for engineering disciplines show petroleum engineers earn a median salary of $114,080, and this field is predicted to grow 17 percent by 2020.

Beginning this fall, the U's Department of Chemical Engineering will offer a new masters degree in petroleum engineering. This 16-month program covers fundamentals in petroleum engineering and petroleum geology, as well as geopolitical and economic considerations. The program, also available through distance education, concludes with a research project.

The oil and gas boom is taking place amidst worldwide concern that hydraulic fracturing could pollute drinking water sources with extraction byproducts, or lead to additional greenhouse gas emissions. The U's petroleum engineering program aims to help engineers understand the scope of unconventional fuel production in a broader context with instructors from the U's Energy and Geoscience Institute, the largest oil and gas industry consortium for exploration and production in the world, with more than 70 member companies.

Deo's research involves modeling multi-component, multi-phase flow in hydraulic fracture networks to understand how these systems behave. These complex simulations span projects across length scales large and small, from fractured reservoirs to nanoscale pores within shale rock. Another area of Deo's research involves ensuring flow in pipelines carrying oil and gas mixtures.

"We have done quite a bit of work on understanding how to minimize and even prevent precipitation in oil wells and pipelines," said Deo. "This is an emerging science of characterization we jokingly call 'petroleomics,'



MIlind Deo / *Chair, Chemical Engineering*

but the impact is no joke—people have lost million-dollar wells because they essentially plug up with solids."

A well or pipeline can become plugged when waxy oils (such as the "black wax" crude oil found in Utah) start precipitating solid wax at room temperature. Crude oil from Alaska's Prudhoe Bay, which accounts for 25 percent of U.S. oil production, comes into the 800 mile-long trans-Alaska pipeline at 100 °F. This four-foot diameter pipeline carries half a million barrels of oil a day and is fully insulated above ground. However, Alaska's frigid winter temperatures suggest a tangible risk of waxes forming in the pipeline. The current strategy, Deo says, is to implement special heat exchangers to heat up the entire pipeline and melt the wax.

"If something were to happen to that line, it would be a major disruption—oil prices would rise by 50 percent," said Deo. "The strategies we are working on are non-brute force—by understanding how the complexities of materials in petroleum behave under different conditions, we can reveal the physics of what really happens in subsurface formations."

INTEGRATED ENGINEERING

In the early years of computer engineering, a computer's entire environment was encompassed in its hardware and software. These days, computer engineers build a variety of devices including wireless and biological systems for ever-growing applications in personalized medicine, business and entertainment.

"In my years of industry experience, I've found people who know both circuits and software are head and shoulders above others in the job market," said Ken Stevens, director of the computer engineering program and associate professor of electrical and computer engineering at the University of Utah.

The U's computer engineering program was ranked number 38 in "America's Best Grad Schools 2014," published by U.S. News & World Report, up nine spots from last year. This unique program addresses three main areas—circuits, software engineering and algorithms—that teach students to build and design integrated systems.

The U's computer engineering program couples principles from electrical engineering and computer science to provide students with an integrated education in the field. Five years ago, 48 undergraduates were in the program; now, 95 students are majoring in computer engineering.

Stevens and his colleagues emphasize to students the need to adapt in their careers. "We teach and study what the trends and restrictions are so we can better adapt designs," Stevens says. "Things are changing so fast. Our students need to be experts in one area, but they must also understand related areas if they want to succeed in the long-term. Change is part of the equation."

After a long career with semiconductor industry giants Fairchild Semiconductor, Hewlett-Packard and Intel, Stevens came to the U in 2005. Since then, his research group is striving to commercialize a high-performance computer circuit that can use one-tenth the power of a traditional computer chip yet deliver the same performance.

Stevens says that the semiconductor industry has reached a saturation point in how much power electronics can expend—a so-called "power wall" that has been exacerbated by mobile and wireless devices.

"In the past, physicists developed new circuits to provide higher-performance, smaller, lower-power transistors. This is getting increasingly difficult," said Stevens. "The onus is now on the design community to create different circuit designs, because at this point there is really no current solution to physically build a better class of transistor."

Stevens' potential solution to this roadblock is called asynchronous design, a technique that changes the way timing works on a computer chip. This technology is the basis of Granite Mountain Technologies, a recently launched startup company that plans to commercialize this asynchronous technology for a broad spectrum of markets.

"Right now, it's pretty easy to build components in the semiconductor industry, but it's pretty hard to build systems. What our technology does is make it simpler to build systems," said Stevens. "The real secret sauce is that we don't have clocks in the chips that we build; instead, we compose things together just like with Legos. By doing this we can optimize for different frequencies, which gives us both a performance and power advantage."

Stevens says this technology could significantly impact the semiconductor industry, whether it's a high performance server, such as the Google server farms, or the smaller power supply in a cell phone.

"I can't stress how much the semiconductor industry has changed the world. Computer engineering has been the driver behind this revolution," said Stevens. "It's been amazing to see us go from black and white televisions when I was a kid to cell phones with more computing power than there was in the entire U.S. 45 years ago. The value we have at the U and in the computer engineering program is to bring people together, brainstorm and build things that really make a difference in the world."

Ken Stevens / *Electrical and Computer Engineering*

NEW FACULTY

MARC CALAF

Mechanical Engineering
Ph.D., mechanical engineering,
École Polytechnique Fédérale de Lausanne

Characterizing the interaction between wind farms and wind energy harvesting systems with the atmospheric boundary layer

BERARDI SENSALE-RODRIGUEZ

Electrical and Computer Engineering
Ph.D., electrical engineering, University of Notre Dame

Terahertz technology, high frequency electronics, plasmonics, and nanophotonics

AMANDA SMITH

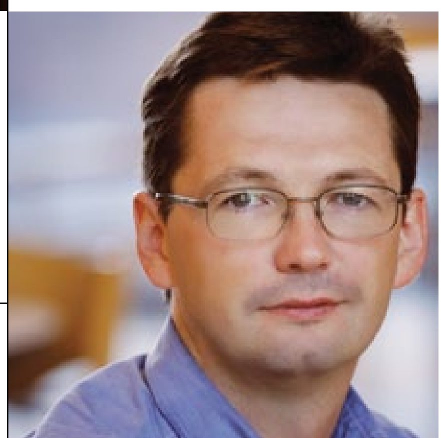
Mechanical Engineering
Ph.D., mechanical engineering,
Mississippi State University

Energy systems analysis, including distributed power generation, heat recovery and thermal storage technologies, and building-energy usage

DMITRY BEDROV

Materials Science and Engineering
Ph.D., chemical engineering, University of Utah

Multiscale molecular modeling of soft condensed matter



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Pixar Animation Studios

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Corning Corporation

Chris Durham
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Merit Medical Systems

Keyvan Esfarjani
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for Engineering Education
Professor and Former Dean of
Engineering, Vanderbilt University

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David S. Layton
President and CEO
The Layton Companies

Paul Mayfield
Partner Group Program Manager
Client Management
Microsoft Corporation

Harold W. Milner
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John R. Njord
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Tom Warne & Assoc., LLC

Jonathan Oomrigar
Global VP High Tech Business Unit
Oracle

Susan D. Opp
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L-3 Communications Systems-West

Lon Perry
President, Quartzdyne, Inc.

Christopher H. Porter
Founder, Medical Genesis, Inc.

Shane V. Robison
Chairman, CEO & President
Fusion-io, Inc.

Lynn S. Scott
Group VP and General Manager*
Parker Hannifin

Michael W. Soulier
Director, Human Resources*
E.I. Du Pont De Nemours & Co.

Dr. Gregory P. Starley
Manager, Exploration Evaluation
Corporate Reservoir Engineering
Apache Corporation

Dr. Gerald B. Stringfellow
Distinguished Professor
University of Utah

Jack Sunderlage
CEO* ,
ContentWatch

Dr. Randal R. Sylvester
Chief Technologist
L-3 Communications Systems-West

Anne Taylor
Vice Chairman and Managing
Partner, Deloitte

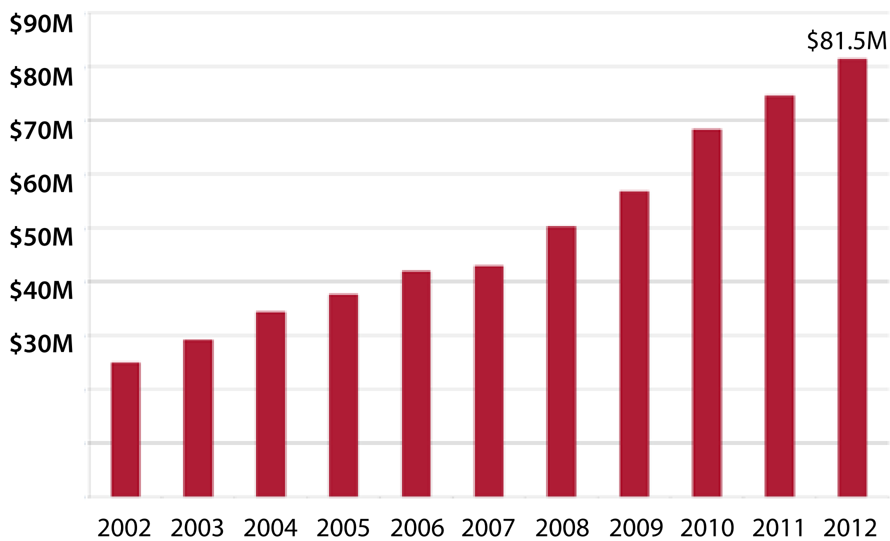
J. Howard Van Boerum
President Emeritus
Van Boerum & Frank Associates

Kim Worsencroft
Technology Entrepreneur

**Retired*

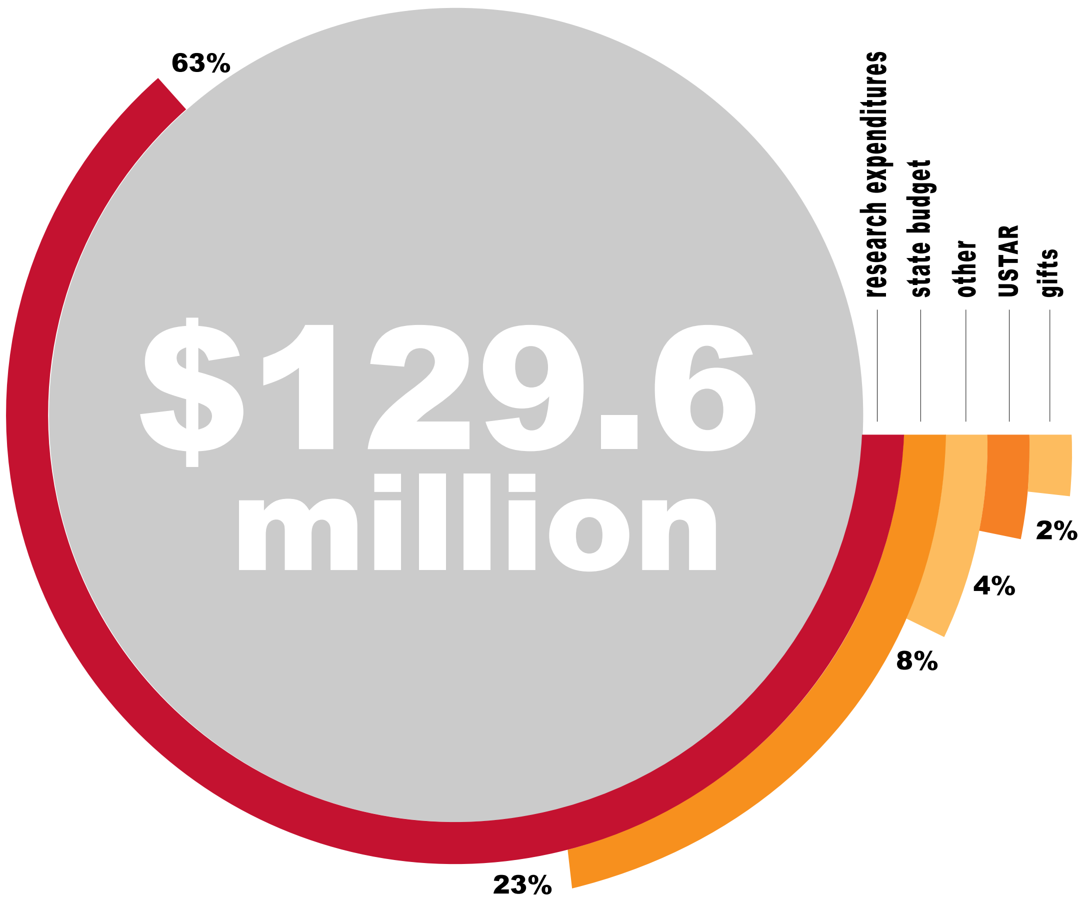
BY THE NUMBERS

RESEARCH EXPENDITURES



With $81.5 million in annual research funding, the University of Utah's College of Engineering is among the top 30 U.S. engineering schools* in research expenditures.

BUDGET 2011 - 2012

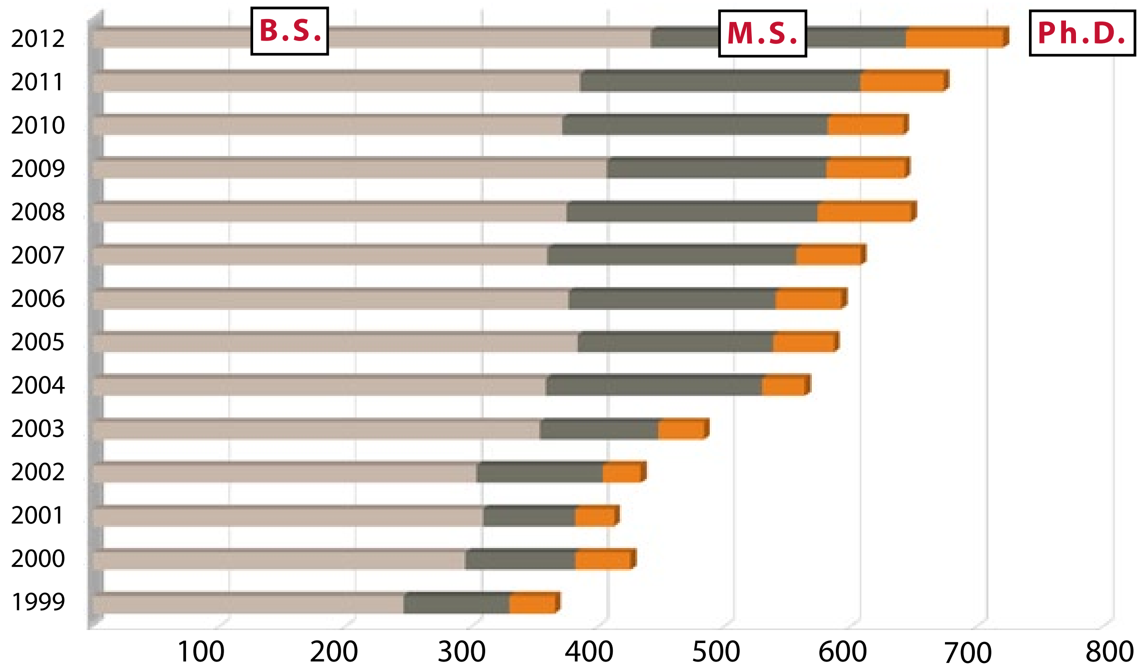


GRADUATES

The College is in the top 40 U.S. engineering schools* in undergraduate degrees and graduate degrees awarded and among the top 50 U.S. engineering schools* in enrollment in 2012:

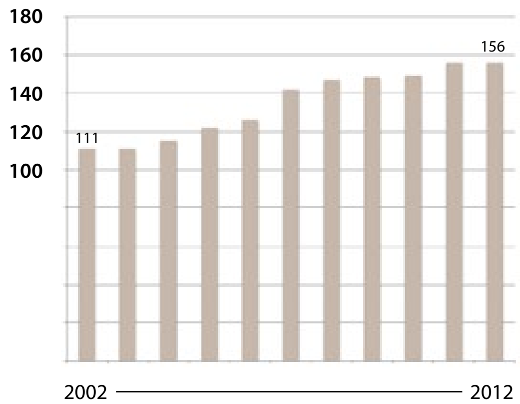
#26 in computer science (of 171 total)
#39 in mechanical engineering (of 288 total)
#34 in doctoral degrees (of 196 total)

#39 in undergraduate enrollment (of 348 total)
#47 in graduate enrollment (of 271 total)



Statistics from Profiles of Engineering and Engineering Technology Colleges, American Society of Engineering Education (2013).

TENURE-TRACK FACULTY

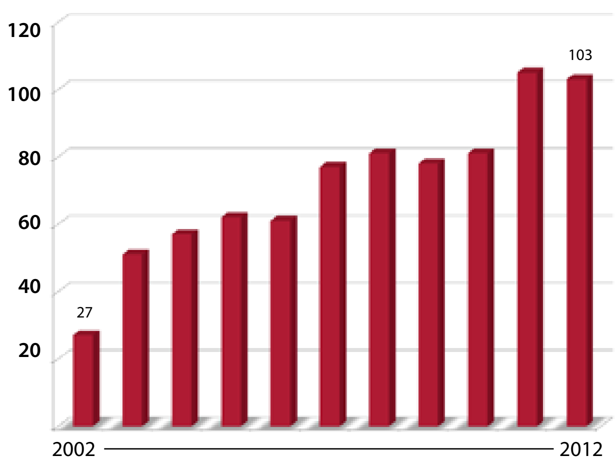


The College is #35 in the number of tenure-track faculty* (of 357 total) in 2012, and ranked in the top 100 engineering/technology and computer science programs in the Academic Ranking of World Universities, developed by Shanghai Jiao Tong University. For 2012, the University of Utah's rankings are:

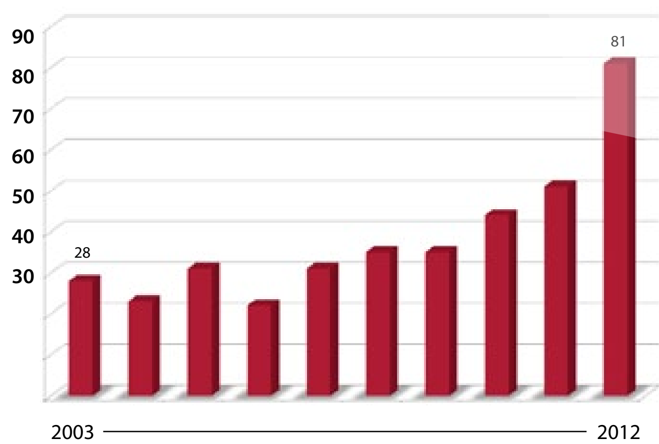
#82 Academic Ranking of World Universities
#76 –100 Engineering and Computer Science
#51 — 75 Computer Science

Faculty in the College continue to successfully commercialize intellectual property through invention disclosures and patents.

INVENTION DISCLOSURES



ISSUED U.S. PATENTS



Clearfield
Layton
Kaysville
Farmington
Bountiful
Holladay
Park City
Antelope Island S.P.
ANTELOPE I.
Salt Lake City
W. Valley City
W. Jordan
Sandy City
American
Alta
97
40
189

LIVING IN UTAH

Utah continues to shine as a model state for economic growth, education, business strength and quality of life. For the sixth year in a row, Utah's economic outlook ranks number one in the nation. In addition, Utah was named the best state for business by Forbes Magazine for the third straight year.

#1 Best Places to Live, CNN

#1 Expected Economic Outlook, American Legislative Exchange Council

#1 Best State for Business, Forbes Magazine

#1 Lowest Healthcare Expenditures, Wall Street Journal

#1 Technology Concentration and Dynamism, Milliken Institute

#1 Small Business Friendliness, Kaufmann Foundation

#1 Best Spot for New Graduates, Kiplinger

#1 Pro-Business State, Pollina Corporate Real Estate

#1 Best Place to Live in the Future, Gallup-Healthways Well-Being Index

#2 Short- and Long-Term Job Growth, U.S. Chamber of Commerce

#3 STEM Job Growth, U.S. Chamber of Commerce

Salt Lake City one of 15 Best New Cities for Business Worldwide, Fortune Magazine

BUILDERS OF TOMORROW

Home to seven academic departments and four interdisciplinary academic programs, University of Utah's College of Engineering is poised to address some of our country's most critical engineering challenges. Our faculty also participate in 27 multidisciplinary research centers and institutes.

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.

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.

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 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.

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, microsystems, manufacturing, design, solid mechanics, thermal fluids and energy systems.

Chemical Engineering
Spanning molecular to large, refinery unit operation length scales, this department specializes in energy and fuels, multiscale simulation, reaction engineering, rheology, systems and controls.

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, entertainment arts and engineering, information management and digital media.

Entertainment Arts and Engineering Program
A unique interdisciplinary 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 video game design/production and interactive entertainment.

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

Utah Nuclear Engineering Program
Innovating for 21st century nuclear engineering education, this program accentuates nuclear reactor modeling and detection, nuclear medicine, nuclear forensics, robust computational methods and radiation shielding analysis for space missions.

Petroleum Engineering Program
Providing petroleum engineering fundamentals and advanced topics, this program will encompass geologic concepts as well as exposure to constraints on energy technologies (geopolitical and economic considerations, environmental issues).

MULTIDISCIPLINARY RESEARCH INSTITUTES AND CENTERS

Scientific Computing and Imaging Institute
Institute for Clean and Secure Energy
Energy & Geoscience Institute
Nano Institute
Utah Nanofab
Cardiovascular Research and Training Institute
Brain 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
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

ALUMNISPOTLIGHT

After eight weeks of engineering challenges and triumphs, U civil engineering alumnus Mark Fuller crowned a winner on the Discovery Channel's competition series "The Big Brain Theory: Pure Genius."

Fuller, who developed a large-scale laminar flow nozzle as part of his undergraduate thesis while at the U, is CEO of WET, an architectural water design firm best known for the Fountains of Bellagio in Las Vegas. A member of the U's Engineering National Advisory Board, Fuller was co-executive producer of "Big Brain" and served as a judge on the show hosted by actor Kal Penn.

The culmination of a months-long collaboration between Fuller and Craig Piligian of Pilgrim Films, "Big Brain" featured a seemingly impossible engineering challenge to be solved by the ten contestants each week on location at WET in Southern California's San Fernando Valley.

Competitors were given 30 minutes to devise a solution to each challenge—many of which were designed by Fuller—using their own intellect. The contestants also lived in one of the WET buildings converted into a dorm.

The judges then evaluated contestants based on the logic and design of their proposed solution, and selected two captains to lead their team to execute a given project. The team with the best design remained safe each week, while the losers faced the judges – and possible elimination.

Competition winner Corey Fleischer successfully navigated a series of eight challenges including harnessing a waterfall to power an elevator and creating a portable bridge to be deployed from the bed of a truck. Fleischer, a mechanical engineer working at Lockheed Martin, won $50,000 and a one-year contract to work with Fuller at WET.

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