University of Utah College of Engineering

research report

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FROM THE DEAN

This year marks the 125th anniversary of engineering education at the University of Utah. Joseph F. Merrill, our founding dean, had a vision for a program built on educational excellence, ground-breaking research, and industry engagement. Merrill was among the first to secure federally funded research from the U.S. Department of Mines and the first to secure legislation from the state which provided a line-item appropriation for graduate level research fellowships. Merrill's vision continues to define our ongoing mission and the values embraced by the faculty.

Through the weeks and months since the pandemic began, I have witnessed daily the strength and resiliency of our faculty, students, and staff. Many of our faculty members pivoted quickly to confront and contain the COVID-19 virus with research projects aimed at virus transmission, rapid detection and tracking. You will read about some of those projects in the following pages. Our alumni have also responded in unique and amazing ways.

Through these challenging times, we have all experienced the extraordinary degree to which technology is sustaining our world. As recently as 10 years ago, we would not have had the computing infrastructure needed to withstand the overnight transition to online "everything." Built on a strong foundation in the last century, the more recent advances in speed, bandwidth, applications, and security have allowed life to continue.

I have no doubt that the massive investments being made in understanding and overcoming the COVID-19 virus will only accelerate the discoveries of the future. And the adaptations we are making in remote working and learning may ultimately improve and strengthen traditional ways of doing business.

What will not change, however, is the need to prepare the technology pioneers, innovators, and leaders of the future. The College of Engineering will continue to fulfill its mission to the people of Utah and the vision articulated 125 years ago by Joseph Merrill. We will sustain Utah's economy by providing the state's premier engineering graduates, we will support local industry, and our faculty and graduates will lead the advances that will continue to transform our world.

Richard B. Brown
Dean, College of Engineering

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125 YEARS OF EXCELLENCE

One hundred and twenty-five years ago, the University of Utah enrolled the curriculum for a modern engineering degree. Dedicated to supporting Utah's mining industry, it was among the first engineering programs west of the Mississippi River. Fresh from Johns Hopkins University, Joseph F. Merrill was appointed the first principal (dean) and Richard Lyman was recruited from Brigham Young Academy to teach the technical engineering curriculum. Merrill's vision was a college that would remain aligned with local industry while engaging in research to drive innovation.

Through more than a century of growth that witnessed the world's most significant technological advances, the College of Engineering also evolved. Today, the U is the leading producer of BS, MS and Ph.D. engineering and computer science graduates in Utah's statewide system. In May 2020, the college contributed 1,184 new graduates to the technical workforce. And externally funded engineering research expenditures at the U last year exceeded $97 million.

At every turning point in the nation's history, College of Engineering graduates and faculty have been at the forefront of dramatic changes. In 1953, electrical engineering graduate Simon Ramo left Hughes Aircraft to cofound the Ramo-Wooldridge Corporation where he led the development of the ballistic missile system. In the 1970's, William R. Gould pioneered nuclear power as an alternative energy source as board chairman of Southern California Edison. And, as deputy associate administrator for space development at NASA, mechanical engineering alum Gretchen McClain was responsible for the successful development and launch of the International Space Station.

The College of Engineering's "Camelot Era" of the 1960's and '70s saw the nation's greatest concentration of talent in the emerging field of computer graphics, under the direction of faculty members David Evans and Ivan Sutherland. Other pioneers among College of Engineering faculty include Professor Thomas Stockham, who is responsible for the technology behind digital sound, and former Dean Gerald Stringfellow, who invented the process for the revolution in LED lighting. The Department of Biomedical Engineering had its genesis in the pioneering work on the artificial heart and the development of an implantable neuro sensor array.

Beginning in 2001, the college experienced another renaissance with the tripling of the undergraduate enrollment and the doubling of the number of faculty. More than ever before, College of Engineering graduates are needed to support Utah's economic dynamism by providing the highly skilled workforce behind one the nation's top-ranked states for new job growth.

In the past, engineering graduates went to work in the state's mining, construction, and public utility sectors. Today, graduates can look forward to satisfying careers in companies like Micron, L3Harris, Adobe and Hill Air Force Base. As Utah recovers from the effects of the pandemic, College of Engineering faculty and graduates will again be at the forefront of advances that will ultimately reshape the world around us.

THE LEADING EDGE

BETTER PREDICTOR FOR CANCER

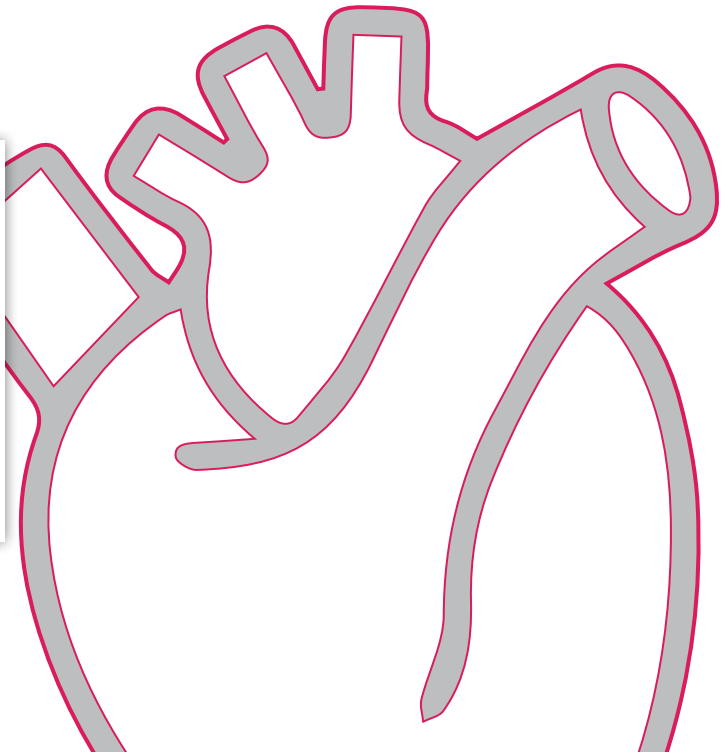
Biomedical engineering associate professor Orly Alter is leading a team that has experimentally validated a predictor for the life expectancy of a patient with glioblastoma (GBM) — the most common and most aggressive brain cancer — that is not only more accurate but also more clinically relevant. It involves a pattern of co-occurring changes in DNA abundance levels, or copy numbers, at hundreds of thousands of sites across the whole tumor genome. The information contained in this pattern can improve the standard of care of GBM and other diseases.

QUANTUM LEAP

Materials science and engineering professor Feng Liu and associate professor Taylor Sparks are part of a team to receive a $1.6 million grant to research fundamental building blocks of quantum computers, the quantum logic units, or "qubits," that encode information in quantum computing. Qubits contain much more information than the binary bits in conventional computers. A new type of material called a three-dimensional topological insulator is one of the best candidates from which to create resilient qubits that will persist in holding their quantum information.

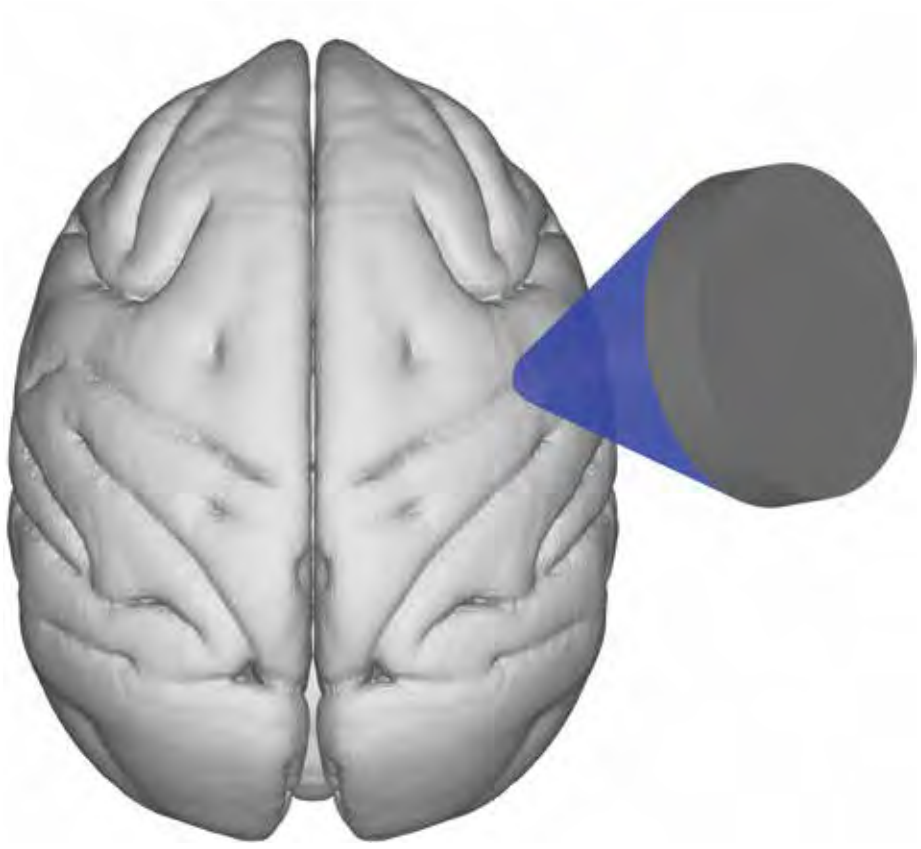
HEART DISEASE

University of Utah biomedical engineering assistant professor Lucas Timmins has received a five-year $1.7 million grant to develop a better way to predict whether a person is at greater risk for heart disease by looking at the mechanics of the heart's arteries (coronary arteries), such as how stiff the arteries become when diseased and how much additional stress that creates. Using image-based computer modeling, researchers can better understand the biomechanics of heart disease and how they affect the progression of the disease.



SOUND TREATMENT

Biomedical engineering assistant professor Jan Kubanek has discovered that treatments of brain disorders may not require drugs or invasive surgery at all – just sound waves. Kubanek has found that high frequency sound waves (ultrasound) emitted into a patient's brain can alter the person's mental state. This could result in a non-invasive, non-pharmaceutical treatment for mental disorders including depression and anxiety, and neurological disorders such as chronic pain and epilepsy.



THIN TO WIN

The new wave of smartphones to hit the market all come with incredible cameras that produce brilliant photos. There's only one complaint — the thick camera lenses on the back that jut out as ugly bumps. U electrical and computer engineering associate professors Rajesh Menon and Berardi Sensale-Rodriguez are part of a team that has developed a new kind of optical lens that is much thinner and lighter than conventional camera lenses, and also works well in low light. This could be a boon for smartphones that could flatten those unsightly "camera bumps," as well as for drones and night vision cameras for soldiers.

AWARD-WINNING WiFIRE

School of Computing professor Sneha Kumar Kasera and doctoral students Christopher Becker and Aniqua Baset are part of a team that have received the prestigious "R&D 100 Award" from R&D World magazine for their development of a system for Wireless radio Frequency signal Identification and protocol Reverse Engineering, or WiFIRE. WiFIRE involves the use of software-defined radios as well as new software that can continuously monitor the wireless spectrum. It can identify multiple types of signals in real time, trace them and report if any are from unauthorized wireless users.

BUNDLE OF ENERGY

Over 73,000 people lost power when a 5.7-magnitude earthquake shook parts of northern Utah in March 2020 and left power systems exposed. The cutoff only caused more anxiety to an already rattled community in the age of COVID-19.

University of Utah electrical and computer engineering associate professor Masood Parvania is working to make the power grid more robust to the threats of cyberattacks and natural and weather-related disasters like the Utah quake.

"We see more and more of these natural disasters happening all over the country, so we want to make sure that the power grid is more resilient, not only against the natural disasters, but also against cyberattacks by adversaries," he said. "We need to integrate more communication, control and (Internet of Things) technologies into the grid so we can create a more efficient and resilient grid for the 21st Century."

Inspired by the trend of disasters impacting the power grid, Parvania knew something had to be done. Parvania, and his team at the Utah Smart Energy Laboratory (U-Smart) and their industry partners hope that by modernizing the grid they can protect it.

Parvania and his team at U-Smart Laboratory are currently leading multiple federal grants to develop solutions to enhance the resilience of the power grid.

The lab is working on new control schemes for optimizing local interdependent power, water, and transportation systems to enhance their strength against natural disasters in future "smart cities." It's also developing new optimization models that could improve the economic efficiency and reliability of power systems that integrate renewable energy resources, energy storage devices and flexible loads. And the lab is examining the economics associated with these technologies in an effort to reduce the operating costs of power systems.

Before rolling out new technology for customers, researchers at U-Smart are using the Cyber-Physical Power System Resilience (CPSR) testbed to implement, test and verify cyber and physical

solutions for power systems in the lab environment. The CPSR testbed offers a platform for real-time simulation of power systems in concert with cutting-edge real-world monitoring, control, and protection devices.

Reinventing the strength and security of the power grid is a project that effectively leverages Parvania's years of study and research. This includes both master's and Ph.D. degrees at the Sharif University of Technology in Iran, as well as his contributions to a campus-wide microgrid at the Illinois Institute of Technology. He also strengthened the cyber security of power grids at the University of California, Davis, and Arizona State University.

With competing offers to further expand his research from institutions across the US, Parvania saw the greatest opportunities for advancement at the University of Utah.

"At Utah, I can continue to innovate while educating the students and engineers most needed for the state and the nation," Parvania said. "It's fulfilling to match my expertise with local industry interest and demand."

ATTACK THE VIRUS!

In a recent opinion editorial for the Desert News, University of Utah President Ruth Watkins spoke eloquently about the importance of the research university. "At the University of Utah, at least 100 research groups are currently studying causes and consequences of COVID-19. Virtually every entity at the U is involved, including undergraduate students and staff who are assisting in and supporting research projects while working remotely. We will prevail over COVID-19 because of research and discovery, much of it fueled by the innovation of university-based scholars."

Much of this work involves College of Engineering faculty.

"It has been inspiring to see our faculty tackle all dimensions of COVID-19. We have researchers in every department working on projects," said Kevin Whitty, associate dean of research for the University of Utah's College of Engineering. "The expertise of our faculty, state-of-the-art facilities and strong collaboration with health sciences puts the College of Engineering in a great position to help in the fight against the disease."

Here are some of the projects that have received both state and federal funding to develop technologies in the fight against COVID-19.

Glycocalyx engineering to probe the role of mucin structure in coronavirus transmission and infection (Biomedical Engineering Assistant Professor Jessica Kramer)

Kramer is researching how mucus plays a part in transferring coronaviruses from person to person. She and her team will create different forms of synthetic mucins, the proteins that make up mucus, and test them with non-hazardous versions of coronaviruses. Understanding how different compositions of the proteins that make up mucus spread coronaviruses could help identify those who are "super-spreaders" as well as those who could be more vulnerable to becoming infected.

Chemical free inactivation of coronavirus via electroactive nanostructured cupric oxide (ENCO) (Chemical Engineering Assistant Professor Swomitra Mohanty)

Mohanty and his team have developed a nanostructure from a form of copper (Cu2+) that can deactivate the virus by interacting with the nucleic acids that make up the virus and their outer protein membrane. This material, which is chemical free, could be used in N95 masks to neutralize the virus as it is drawn into the mask or in hospital air filtration systems.

Disinfecting nanobubble shield against COVID-19 in hospital ER/ICU environments (Civil and Environmental Engineering Professor P.K. Andy Hong)

This technology creates an air defense shield in hospital emergency rooms and ICU rooms with invisible microdroplets of mist that carry smaller nanobubbles of air with a virucide – benzalkonium chloride – to disinfect the air. This mist can prevent viral cough droplets from traveling in the air by killing the virus with the disinfectant. The technology also can be used to disinfect hospital water that is commonly invaded by pathogens.

Municipal wastewater monitoring based surveillance and prediction tools for community level occurrence and spread of COVID-19 (Civil and Environmental Engineering Associate Professor Jennifer Weidhaas and Civil and Environmental Engineering Professor Ramesh Goel)

Weidhaas and Goel are researching whether studying concentrations of COVID-19 in samples from city wastewater sewage facilities can give them an accurate reading of how many people have the virus in a particular area served by each facility. The virus is excreted from people through their feces and urine that eventually is flushed into sewage plants. Goel is also using the samples to determine if there are different strains of the virus in different regions.

Enabling the in-situ real-time detection of COVID-19 viruses via a quantum tunneling-based nanogap sensor (Electrical and Computer Engineering Associate Professor Hanseup Kim)

Kim is developing an on-spot detection system for the virus that can alert people when it is present in an area. It involves using quantum tunneling phenomena to create a real-time sensor that detects the COVID-19 virus, with a sensitivity enhancement greater than a thousand times compared to the most recent sensor technology.

Multiplexed detection of COVID-19/SARS-CoV-2 biomarkers for diagnosis and surveillance (Electrical and Computer Engineering Research Assistant Professor Lars Laurentius and Chemical Engineering Professor Marc Porter)

Based on an existing platform they have developed for other infectious diseases, Laurentius and Porter are developing a point-of-care diagnostic test for the simultaneous detection of virus biomarkers and immune response antibodies in patients to capture different stages of the infection. This could lead to a rapid, inexpensive, and potentially more accurate test than what is currently being used nationwide.

Rapid Microfluidic Synthesis of Novel SARS-CoV-2 Entry Inhibitor Antiviral Drugs (Electrical and Computer Engineering Professor Carlos Mastrangelo)

Finding the right drug compound in a pharmaceutical company's vast library to treat COVID-19 can be a lengthy process. Mastrangelo is developing a rapid system for the synthesis of new antiviral drugs with a new process involving a microfluidic device. His new synthesis system could rapidly produce new antivirals from existing information about the virus, avoiding a random search entirely.

Detection of Airborne COVID-19 Using Capsid Protein Aptamers in Exhaled Air (Electrical and Computer Engineering, USTAR Professor Massood Tabib-Azar)

Tabib-Azar is developing a reusable, portable sensor about the size of a quarter that can detect the presence of the virus in people or the environment. The sensor can either be a standalone device or work with a cellphone and can produce results in about a minute.

AI/CXR early warning system for infectious respiratory disease outbreaks (Electrical and Computer Engineering Professor Tolga Tasdizen)

Tasdizen is developing an early warning system for respiratory infection outbreaks using Artificial Intelligence analysis of routine chest x-rays. By using software and machine learning, healthcare systems could analyze chest x-rays in databases to look for certain deviations related to a virus. That in turn creates an AI model in which future x-rays input into the system would automatically search for those deviations and determine seasonal and local patterns. This could help national and local governments to determine early where a virus breakout might happen.

COVID: Understanding the capturing and evolution behavior of wetting and non-wetting aerosols on nanofibers matrix (Mechanical Engineering Assistant Professor Jiyoung Chang)

The most effective way, at least for now, to prevent the contraction of coronavirus in aerosol is wearing face masks. A nanoscale fiber membrane could provide an effective and affordable solution for the filtration of a virus aerosol. Chang's research aims to investigate the nanoscale capture and evolution of aerosols on polyimide nanofibers, which can serve as an important foundation for the development of advanced filters and masks.

Synthesis of easily sterilizable and reusable xerogel filters for N95 respirators (Metallurgical Engineering Assistant Professor Krista Carlson)

Carlson is developing a silica xerogel filter that provides the same efficiency as a N95 filter, but unlike the single-use respirators or current filters for reusable respirators, these xerogel filters can be repeatedly sterilized for reuse. Filters will be made by drying silica-based gels to obtain crack-free xerogel filters that fit into reusable respirators.

bionic BREAKTHROUGH

Slipping on the mechanical prototype of the "Utah Bionic Leg," Kerry Finn felt a power and control that he hadn't experienced since he lost his leg 13 years ago to type 2 diabetes.

"It made me feel like I could do things I could not do before," said the retired Utah truck driver, one of 12 people who have tested the leg. "Every time I made a step, it was an awesome feeling."

With an array of built-in sensors and powerful motors, the Utah Bionic Leg gave Finn the energy and agility to walk with more comfort and ease, stepping over obstacles, and even stand up and sit down with less effort and strain.

The "Utah Bionic Leg" was designed and built by University of Utah mechanical engineering assistant professor Tommaso Lenzi and his team of students in the Bionic Engineering Lab. Their project to produce the world's first lightweight bionic leg has recently received grants from the National Institutes of Health and the National Science Foundation to further develop the technology.

The purpose of the leg is to make the wearer better, stronger, and faster, albeit not in the way Steve Austin was made in the fictional "Six Million Dollar Man." Instead, the Utah Bionic Leg is geared specifically toward older amputees who could benefit the most from the extra power and control offered by a bionic leg to navigate through everyday activities from walking longer distances to taking the stairs.

The bionic leg has sensors, motors, a computer processor, and artificial intelligence that all work in conjunction to give the user more power to walk with less stress on the body than with a standard prosthesis.

"If you walk faster, it will walk faster for you and give you more energy. It adapts automatically to the height of the step. It can even help you cross over obstacles," Lenzi says.

The leg uses custom-designed force and torque sensors as well as accelerometers and gyroscopes to help determine the leg's position in space. Those sensors are connected to the onboard computer processor that interprets the signals to determine the user's intended movements. Based on that real-time data, the computer then controls the motors in the prosthetic joints to assist the user with the intended activity. The leg also has a smart transmission system. Similar to gears on a bicycle, it adapts to the demands of different activities, providing additional torque when it senses the wearer is walking up a slope or provides less torque and more speed when the person is walking faster.

For example, the leg gave Finn the ability to walk upstairs two steps at a time and to walk with less exertion. "You don't have to work as hard. And it takes a lot of the stress off the body," he said.

Most recently, the team has integrated neural signals from the user's residual limb to control the torque generated by the leg, providing the person with more control of the prosthesis movements. For example, the neural controller manages how much assistance the person receives from the bionic leg while standing up.

At about six pounds, the leg is also about half the weight of a typical prosthetic which allows the wearer to use it much longer before getting tired. It's not just because of the lightweight materials Lenzi's team uses but also because the electronic systems and motors are optimized to work together, he said.

So far, a dozen people have tried the prototype in the laboratory, and Lenzi has even bigger plans for the future. Soon, he will let subjects take a new version of the Utah Bionic Leg home to see how it performs in real-world conditions. "There is a lot we can learn by looking at how people use this device outside of the laboratory," he said.

Lenzi, who got his doctorate degree in biorobotics from Scuola Superiore Sant'Anna in Pisa, Italy, became interested in designing a smarter prosthetic leg while working at the Rehabilitation Institute of Chicago.

"I had a chance to interact with many people with amputations and their significant others. Getting to know them personally and understanding their struggle with available technologies motivated me to develop something better," he said. "While a lot of people thought it was not possible, I have always had faith in the power of engineers to solve problems. Now we have a first demonstration that it can be done. I hope our work will be the starting point for a revolution in prosthetics."

TECHNOLOGY AND THE PAND

EMIC

Nine months ago, the concepts of shelter-in-place, social distancing and self-isolation would have been inconceivable to a world as connected as ours. Yet despite the massive disruption to daily life, the miracle of modern technology allowed the world to keep turning. One estimate reported that 55 million schoolchildren began learning online alongside their remote-working parents. The number of daily Zoom sessions rose from 10 million to 200 million.

The average user might not appreciate that many advances in bandwidth, digital platforms, and data speed are relatively recent. According to NCTA - The Internet & Television Association, top broadband speeds have increased exponentially over the last decade. In 2008, only 16% of Americans had access to internet service of 10 Mbps. Today, 95% of Americans can access a 10 Mbps connection and 1 gigabit speeds are available to 80%.

The College of Engineering graduates who pioneered the information age, like John Warnock, Alan Kay, and Jim Clark, could not have imagined a scenario like the pandemic in which a computer screen would facilitate so much human interaction. According to John Warnock, who was present at the birth of the ARPANET, the modern-day internet is now 90,000 times faster than the original five-node network.

In the early 1960's, University of Utah physics graduates Frank Wanlass and Ed Snow were pioneering semiconductor technology. Wanlass invented CMOS, the technology on which all microprocessors and most other circuitry is made. Snow was an important contributor to the early understanding of the properties of metal-oxide-semiconductor structures. Today, we honor those pioneers and generations of their successors whose discoveries are now powering our world.

In the midst of the pandemic, progress continues, and College of Engineering graduates are finding new opportunities to innovate. Early on, many alumni and their companies converted manufacturing processes to the production of masks, PPEs, and ventilators. Other problems required a more targeted response, including these three compelling examples.

John LaLonde (BCS '89) is chair of the college's Engineering National Advisory Council. He also serves on the board of Bright Path Labs, a biotech company with a unique manufacturing technology for critical pharmaceuticals. Because roughly 80% of the basic components used in U.S. drugs, known as active pharmaceutical ingredients (APIs), come from India and China, the pandemic exposed gaps in the U.S. drug supply.

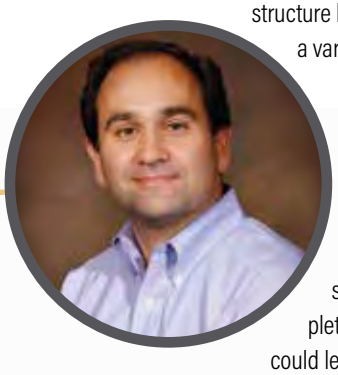
Bright Path Labs is filling those gaps through the agile manufacturing of medications, vaccines, and other potential treatments. According to LaLonde, "There is an urgent need for parallel manufacturing so that basic drug components can be produced domestically. Additionally, there are many researchers all trying to create new drugs and get testing done in an extremely compressed time cycle. They may initially need product in small amounts but, once proven, need to ramp up to large quantities."

Unlike conventional batch manufacturing which is time consuming and typically done on a large scale, Bright Path Labs uses continuous flow reactors that can produce drugs immediately

and in quantities from small to large. Currently, the company has the only FDA-approved continuous flow manufacturing of APIs.

In addition to addressing the current crisis, LaLonde hopes this game-changing technology will provide hope for the sufferers of so-called orphan diseases who frequently go untreated because they require small quantities of highly specialized medications which may not be profitable for large drug companies.

Another company focused on the U.S. supply chain is Merit Medical Systems, a leading manufacturer of disposable medical devices used in interventional, diagnostic, and therapeutic procedures. According to Chris Durham, (MS BioE '98, BSEE '91), Merit's Executive VP of Acquisitions and Product Integration, "Merit utilizes a highly vertical supply chain and does not have manufacturing facilities in China. Its diverse distribution structure has prepared the company for a variety of scenarios."



Recently, Merit has begun producing a swab for COVID-19 testing and will soon have complete kits available on the market for transporting test samples. The swab is a completely new product for Merit and could lead to additional opportunities in the future with transport media kits and related products. Durham noted: "It was the engineering and STEM trained personnel who worked through all of the details at warp-speed to get our swab designed and produced. It would have been impossible without them."

Other College of Engineering alumni are focused on challenges of sustaining global IT infrastructure. Paul Mayfield (BCS '97) is a CTO at Microsoft Corporation in a team that builds security and management infrastructure for large organizations. He noted that cloud computing "is one of the great disruptive innovations in computer science that allowed society to so quickly adapt to remote learning and remote work." Just six years ago, Mayfield found customers resisting the use of the cloud based on perceptions around reliability and security.

"By 2018, most organizations, even government and finance customers, had migrated to cloud infrastructure as a top strategic priority. Our usage took off exponentially. Had cloud computing not completely disrupted the traditional ways of using technology at work, there would be no Zoom or Teams today," Mayfield said.

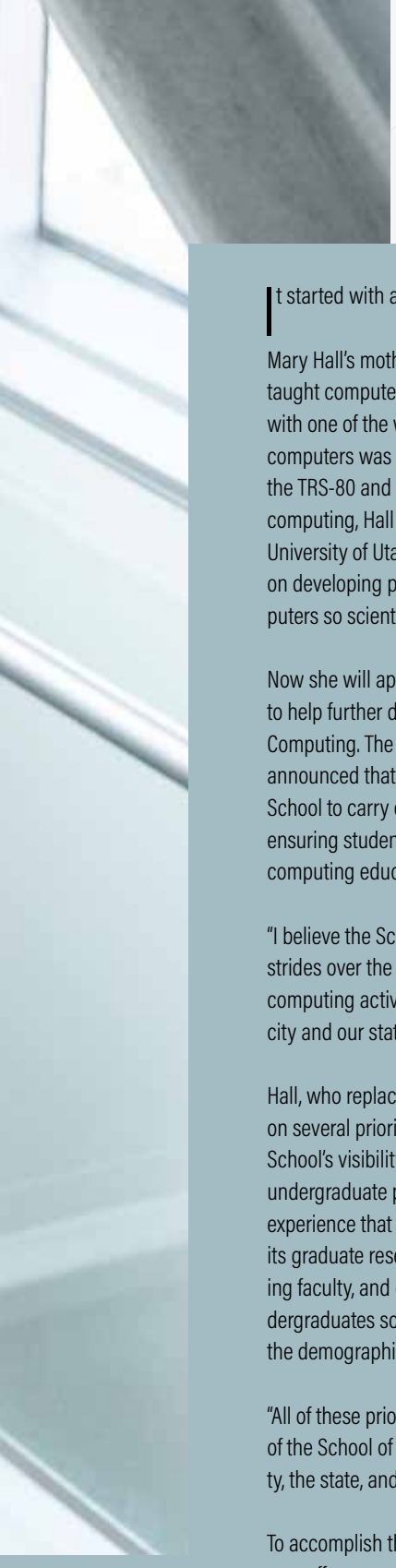
He noticed another change in the past few months. "One thing we learned is that remote work is a great equalizer. It can have a profound effect on team culture. For example, our more introverted team members can more easily participate in meetings by posting comments via chat."

Mayfield added: "I'm hopeful that as working remotely becomes normalized, it will lead to technical innovations that support more democratized access to opportunity. I believe (hope) we'll see technology evolve to bring jobs out of the urban centers to any location, level the playing field for people with disabilities, overcome language barriers, accommodate needs that different people have for flexible work hours, etc."

Technology will continue to play an essential role in addressing the global challenges now and in the future. And research universities like the University of Utah will need to continue to prepare the pioneers, the innovators, and the technology leaders of the future.

Mayfield summed it up perfectly: "Engineering is needed to sustain our way of life because our way of life will always be challenged by new problems that need to be solved. Technologies will need to be created as solutions to those problems."

NEW DIRECTIONS



It started with a Radio Shack TRS-80 home computer.

Mary Hall's mother, a middle-school math teacher who also taught computer literacy, brought one home. Getting to tinker with one of the world's first mass-produced enthusiast home computers was a defining time for this teenager. Thanks to the TRS-80 and her inspiring mother who introduced her to computing, Hall later became a preeminent professor in the University of Utah's School of Computing. Her research focuses on developing programming system technology for supercomputers so scientists can produce more efficient code.

Now she will apply her experience in research and education to help further develop the U's nationally recognized School of Computing. The University of Utah College of Engineering has announced that Hall has been named the new director of the School to carry on its tradition of cutting-edge research while ensuring students get the most rigorous and comprehensive computing education available.

"I believe the School of Computing is poised to make great strides over the next several years to become a centerpiece of computing activity, not only for our university but also for our city and our state," she said.

Hall, who replaces outgoing director Ross Whitaker, is focused on several priorities to enhance the department: improve the School's visibility to match the quality of its faculty, grow its undergraduate program by building a curriculum and student experience that engages and retains more students, strengthen its graduate research program to support and sustain a growing faculty, and develop recruiting initiatives for incoming undergraduates so the department's student body better reflects the demographics of the university and the local community.

"All of these priorities will benefit us by increasing the visibility of the School of Computing within the university, the community, the state, and local industry," she said.

To accomplish these priorities, she is advancing several new efforts.

The School is developing plans to revise the undergraduate curriculum to offer different pathways into the major, considering differences in student preparation. She will broaden the School's curriculum with new degree programs that will help meet industry needs.

"We must recognize the breadth of computing and that students come with different preparation and expectations," she said. "We should not have a one-size-fits-all approach. Our graduate curriculum with its tracks reflects this breadth, and our undergraduate program is also moving in this direction with the recent introduction, for example, of the Data Science undergraduate degree. But there is room to do more."

Undergraduate research will be expanded significantly to offer students opportunities to engage with faculty and their research teams to further improve the undergraduate experience. Growing the research program and training graduate students in computer science education are activities aimed at enhancing the student experience. New recruiting efforts for both undergraduate and graduate students – focused on students from neighboring schools – will fuel growth in the School's programs and increase its diversity.

Hall received her doctorate degree in computer science from Rice University. She is a Fellow of the Institute for Electrical and Electronics Engineers and an Association for Computing Machinery Distinguished Scientist.

She is part of a six-year U.S. Department of Energy program to develop compiler technologies that would make it much easier to write software for supercomputers. She is working on the DOE's Exascale Computing Project (ECP), which was launched to prepare the simulations and underlying software technology for anticipated exascale supercomputers. Her work with ECP is to create an automated mapping of the foundational code for supercomputers so programmers can be more productive while programming them. Such computers will be used by the government and researchers for energy simulations, ground water and weather simulations or simulating the power of our nuclear arsenal.

Meanwhile, Hall has been involved in making sure more students from groups underrepresented in computing participate in the department. She is chair of the Women in Engineering Faculty Advisory Council for the U's College of Engineering and served for many years as chair of the School of Computing's diversity committee.

"Mary's credentials in both scientific accomplishments and service are exceptional," said Whitaker, who served as the previous director for six and a half years. "I believe she has a great vision for the future of the School, and I am confident that she will take the School in some new and important directions."

NEW FACULTY

With a national reputation for academic and research excellence and technology commercialization, the University of Utah's College of Engineering continues to attract the world's brightest and most inventive researchers to its faculty ranks. Seven new faculty members will join the faculty this year as the college responds to its growing enrollment.

TAO GAO

Assistant Professor, Chemical Engineering

Bachelor's and Master's in Mechanical Engineering, Tsinghua University; Ph.D. in Chemical Engineering, University of Maryland College Park.

Research interests: Energy storage for electric transportation, renewable integration and robotics, water desalination technology.

HEATHER HOLMES

Assistant Professor, Chemical Engineering

Bachelor's in Mechanical Engineering, Montana State University; Master's in Mechanical Engineering, University of Utah; Ph.D. in Mechanical Engineering, University of Utah.

Research interests: Energy storage for electric transportation, renewable integration and robotics, water desalination technology.

JIANLI CHEN

Assistant Professor, Civil & Environmental Engineering

Bachelor's in Civil Engineering and Computer Engineering, Dalian Jiaotong University; Master's in Civil Engineering, Virginia Polytech Institute and State University; Master's in Computational Science and Engineering, Georgia Institute of Technology; Ph.D. in Building Construction, Georgia Institute of Technology.

Research interests: Computing in building and urban development, renewable energy integration, intelligent control for sustainability and resilience.

WEILU GAO

Assistant Professor, Electrical and Computer Engineering

Bachelor's in Electrical Engineering, Shanghai Jiao Tong University; Master's in Electrical and Computer Engineering, Rice University; Ph.D. in Electrical and Computer Engineering, Rice University.

Research interests: Photonics and optoelectronics of nanomaterials.

BENJAMIN SANCHEZ

Assistant Professor, Electrical and Computer Engineering

Bachelor's in Electrical Engineering, Universitat Politecnica de Catalunya; Bachelor's in Telecommunications Engineering, Universitat Politecnica de Catalunya; Master's in Electrical Engineering, Universitat Politecnica de Catalunya; Ph.D. in Electrical Engineering, Universitat Politecnica de Catalunya.

Research interests: Bioelectricity, electrical bioimpedance, computational electromagnetics, biomedical devices, neuromuscular electro-diagnostics.

JEFF BATES

Assistant Professor, Materials Science and Engineering

Bachelor's in Biology, University of Utah; Master's in Educational Leadership Policy, University of Utah; Ph.D. in Materials Science and Engineering, University of Utah.

Research interests: Polymer materials, hydrogels in optical drug delivery, phase change materials for thermal management systems.

ELIANE WIESE

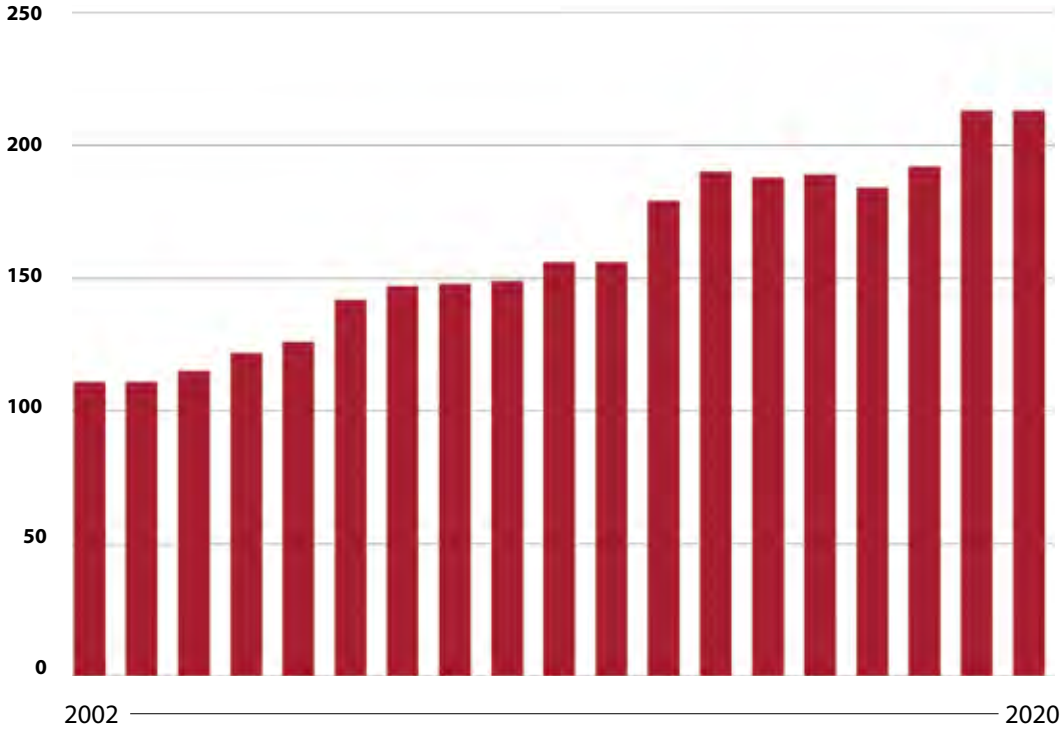
Assistant Professor, School of Computing

Bachelor's in Computer Science, Columbia University; Ph.D. in Human-Computer Interaction, Carnegie Mellon University.

Research interests: Human-computer interaction, ethics and human impact in computer science, math education.

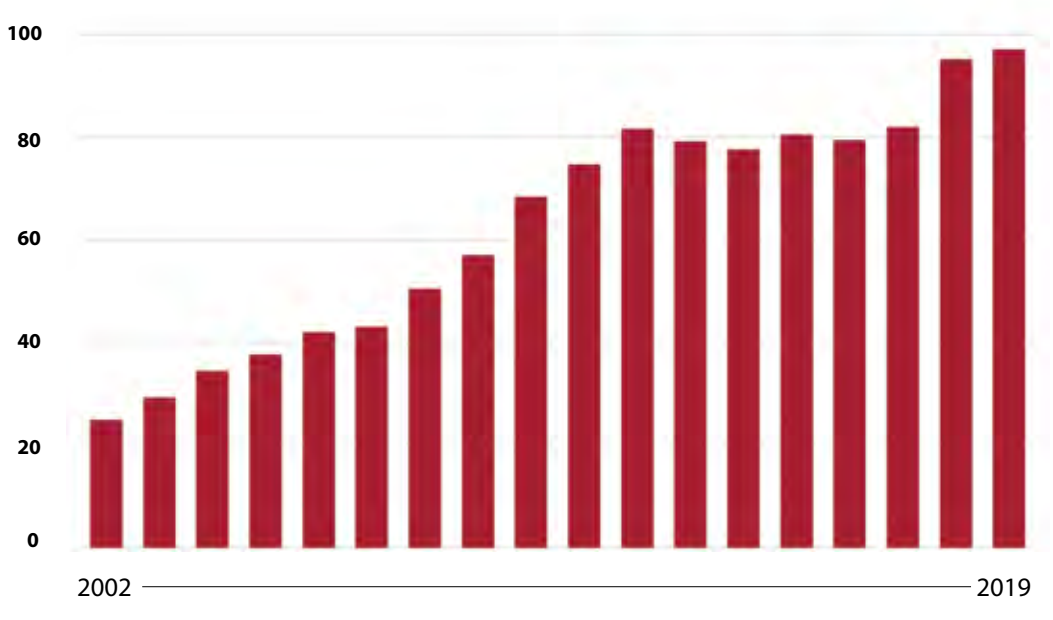
BY THE NUMBERS

TENURE TRACK FACULTY GROWTH



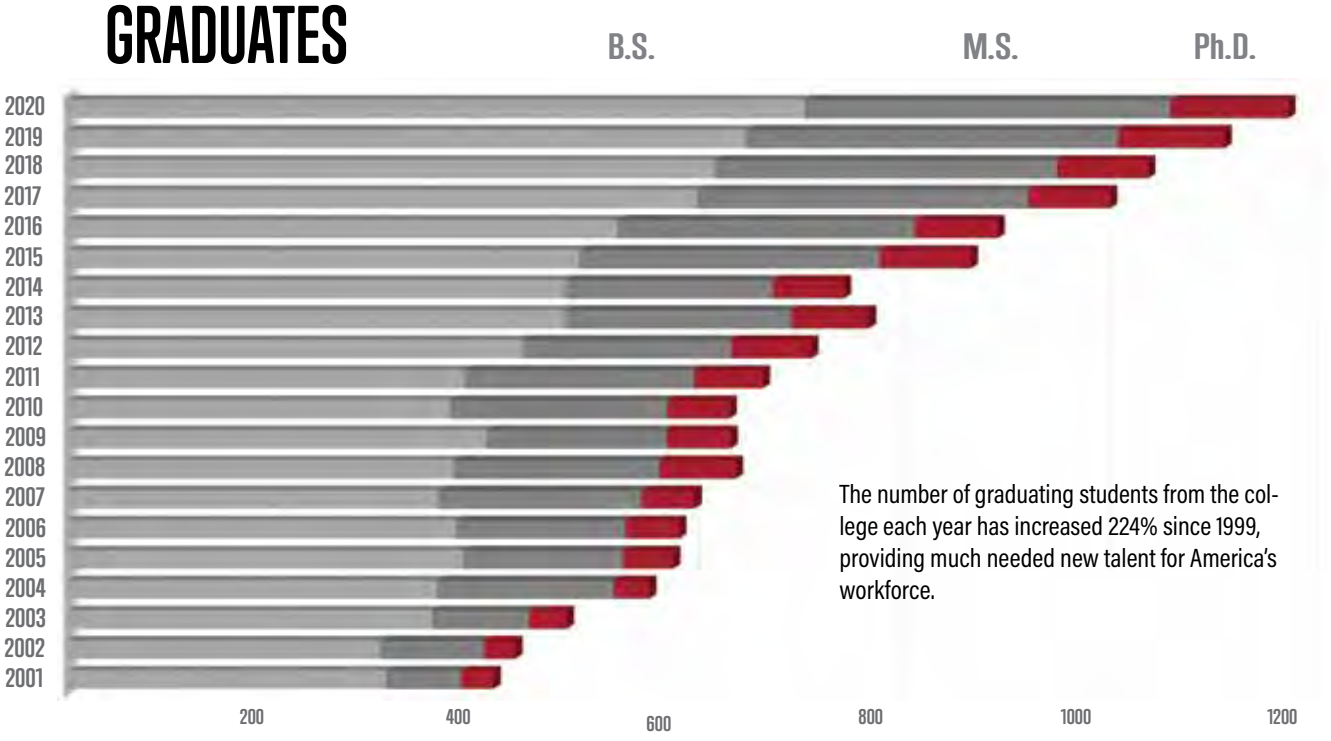
To meet the needs of its growing student body, the University of Utah's College of Engineering has invested in hiring world-class faculty members known for their excellence in research and education. This year, the college has 213 tenure-track faculty members, 92% more than in 2002.

ENGINEERING RESEARCH EXPENDITURES AT THE U



The college is dedicated to developing trailblazing technology for the benefit of society, from medical devices to computer hardware and software. Last year, the university's engineering-related research expenditures continued to grow, reaching more than $97 million (including sub-awards), a 287% increase from 2002.

GRADUATES



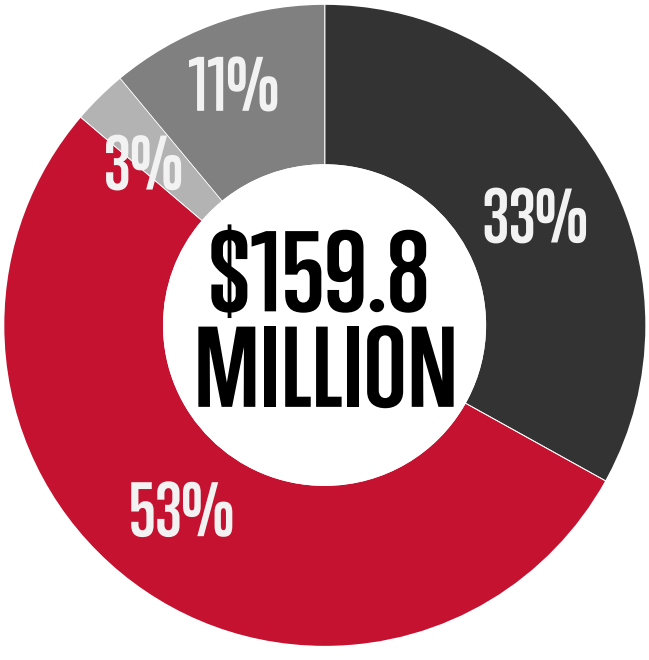
The number of graduating students from the college each year has increased 224% since 1999, providing much needed new talent for America's workforce.

RANKINGS

The University of Utah's College of Engineering is ranked favorably in several areas, according to the 2019 Profiles of Engineering & Engineering Technology by the American Society for Engineering Education, demonstrating its commitment to excellence in research and education.

- Research expenditures — #27 (out of 251 schools)
- Engineering doctoral degrees awarded — #37 (out of 264 schools)
- Doctoral enrollment — #37 (out of 264 schools)
- Tenured/tenure-track faculty members #32 (out of 263 schools)

ENGINEERING BUDGET 2018-2019



- SPONSORED RESEARCH
- STATE APPROPRIATIONS
- OTHER FUNDS
- DONATIONS

COMMERCIALIZING RESEARCH

The University of Utah's College of Engineering has had great success in turning its research ideas into commercial solutions. Since 2010, the college's faculty filed 842 invention disclosures while 104 licenses were executed. Faculty have launched 80 startups from 2006 to 2020.

ALUMNUS PROFILE

CHRIS DURHAM

Engineers know the value of solid connections. Merit Medical Executive Vice President of Acquisition and Product Integration Chris Durham is no exception.

Through his educational and professional endeavors, Durham, a graduate of the University of Utah's College of Engineering, has forged connections in both his education and industry.

Thanks to his schooling at the U as an electrical engineering undergraduate, and later, biomedical engineering graduate student, Durham saw the important connection electronics had in producing powerful medical devices.

"I really liked the instrumentation side and especially as it applied to bio-instrumentation and application, so even in my undergraduate career, I was focusing on some of the classes that had application in medical devices," Durham said, "I really enjoyed looking at technologies and how they could be used in different ways to make our healthcare system and quality of life better."

As an undergraduate, Durham made an important connection with his neighbor: Merit Medical Systems founder Fred Lampropoulos, who had started the company 18 months prior. The Utah-based company designs and manufactures medical devices for a variety of fields including cardiology, radiology, oncology, critical care, and endoscopy. Lampropoulos learned Durham was an engineering student and encouraged him to interview for a position. Durham started working in Merit's research and development department.

"Although I stayed on at Merit after I graduated, my work experience there during my schooling made me much better prepared and marketable when I did graduate," he said, "It is a tremendous advantage to have such experience on a resume at graduation."

Professionally, Durham has extensive experience with Merit Medical Systems and Abbott Laboratories. His work has focused on research and development, quality assurance, and operations management, including Merit's MEMS pressure sensor fabrication. Most recently, Durham has pivoted toward business development, acquisitions, and integration. He has been bringing new units online in the Merit system in places such as Singapore, Australia, and California.

Durham became connected with the College of Engineering through the college's Industry Advisory Board (IAB) and believes the board's work – which advises the dean on curricula, degree offerings and workforce demands – is important because Utah sees economic benefit. He along with the group also promoted the Engineering Initiative, funding from the Utah State legislature to grow the number of engineering and computer science graduates per year into the statewide system.

"[The initiative] is beneficial to the state because it gets a really good return on its tax dollars by educating engineers that help the economy. We always have a need for engineers," said Durham.

Later, he joined the college's Engineering National Advisory Council, a group of industry professionals that counsels the dean on long-term strategic objectives. And Durham was instrumental in connecting College of Engineering Dean Richard Brown with Merit's Lampropoulos. The result is a new Merit Medical endowed chair that began taking form after a site visit and subsequent discussions.

"I think the university and the state of Utah have a world-class College of Engineering at the University of Utah. But competition for talent is fierce, and it is the professors and their research that make the engineering education experience at Utah so rich," Durham said.

Durham said the U's College of Engineering educates and prepares highly qualified engineers who are ready to enter the workforce. "Merit has benefitted from the top engineering talent from the University of Utah, and both Fred (Lampropoulos) and I recognize and appreciate that," he said.

ENAC

UNIVERSITY OF UTAH COLLEGE OF ENGINEERING
ENGINEERING NATIONAL ADVISORY COUNCIL

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David C. Aldous
CEO & Director
Rive Technology, Inc.

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Jerry K. Young
Director, Materials & Manufac-
turing Technology
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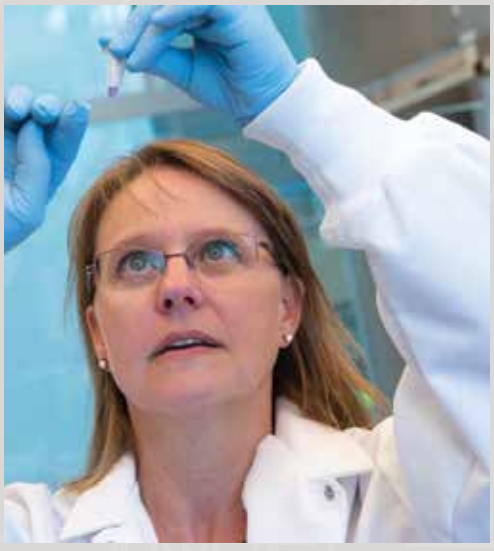
EX OFFICIO

Richard B. Brown
Dean
College of Engineering

Josh Grant
Exec. Director, Development
& External Relations
College of Engineering

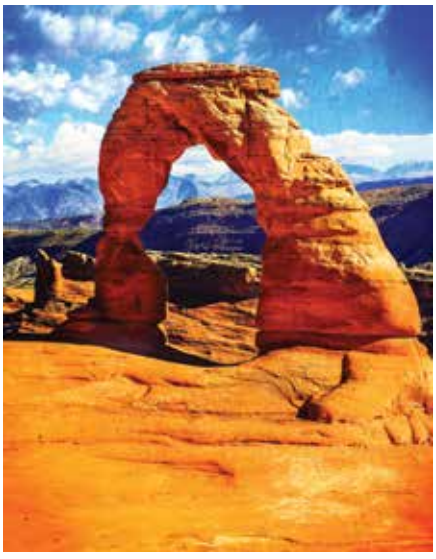
John C. Sutherland
Assistant CIO
Brigham Young University

MULTIDISCIPLINARY RESEARCH CENTERS AND INSTITUTES



- Alliance for Computationally-guided Design of Energy Efficient Electronic Materials
- Biomedical Image and Data Analysis Center
- Carbon Capture Multidisciplinary Simulation Center
- Cardiovascular Research and Training Institute
- Center for Controlled Chemical Delivery
- Center for Engineering Innovation
- Center for Extreme Data Management Analysis and Visualization
- Center for Multi-Scale Fluid-Solid Interactions in Architected and Natural Materials
- Center for Neural Interfaces
- Center of Excellence for Biomedical Microfluidics
- Energy & Geoscience Institute
- Global Change & Sustainability Center
- Institute for Clean and Secure Energy
- Intel Graphics and Visualization Institute
- Intermountain Industrial Assessment Center
- Manufacturing Extension Partnership
- Nano Institute
- NIH Center for Integrative Biomedical Computing
- NSF Center of Excellence for Large Facilities Cyberinfrastructure
- NVIDIA CUDA Center of Excellence
- Scientific Computing and Imaging Institute
- U.S.-Pakistan Centers for Advanced Studies in Water
- University of Utah Robotics Center
- Utah Center for Interfacial Sciences
- Utah Center for NanoBioSensors
- Utah Center for Nanomedicine
- Utah Nanofab

LIFE IN UTAH



Utah can do it all. A robust economy that is proving to weather the global pandemic better than most, an expanding business landscape that has turned Salt Lake City's metropolitan area into a major hub of activity, and a tech sector that is getting international notice. And all of that vibrant growth is occurring among the most gorgeous natural backdrop this country can offer. Here are recent accolades Utah and Salt Lake City have received from national media outlets.

UTAH

#1 Best State for Employment — U.S. News & World Report
#1 Best State Economic Momentum — State Policy Reports
#1 Best State for Entrepreneurs — Forbes
#1 State for the Middle Class — SmartAsset
#2 Best States to Start a Business — Inc.
#2 Best States for Winter Activities — GoAllOutdoors.com
#2 Happiest States in America — WalletHub
#3 Best Economy — 24/7 Wall St.
#3 Best States for Business — Forbes
#4 Best States — U.S. News & World Report
#4 America's Top States for Business — CNBC
#5 Top States for Technology and Science — Milken Institute.
#6 Fastest-Growing Tech States — Business Insider

SALT LAKE CITY

#1 Best Place to Start a Career — CNBC
#2 The 50 Best U.S. Cities for Starting a Business — Inc.
#2 America's Next Boom Towns — Forbes
#3 America's 25 Best Cities for Young Professionals — Forbes
#4 Top 10 Mid-Sized American Cities — fDi Magazine
#4 Most Attractive City — Travel & Leisure
#5 America's Fastest-Growing Cities — Forbes

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