INVENTING TOMORROW

PUTTING KNOWLEDGE TO WORK
Alumni build successful business ventures >>

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Putting Knowledge to Work • 8

Five CSE alumni harnessed their education and entrepreneurial ambitions to start new businesses and transform existing industries.

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College of Science and Engineering students are empowered to use creativity and innovation in building businesses.

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College of Science and Engineering faculty turn research into successful business ventures.

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Serving students, faculty, and researchers for more than 86 years, Tate Laboratory is in need of a renovation.

BY SILVA YOUNG
Invention, business savvy are alive and well at the U

JOBS EVERYWHERE YOU TURN THESE PAST FEW YEARS, you hear about jobs. Everyone is talking about how to get more people back to work and how to stimulate the economy through innovation and entrepreneurship. For us, this is not a new topic. Our University of Minnesota College of Science and Engineering alumni, faculty, and students have a long history of innovation that leads to business development. In fact, a survey we conducted a few years ago showed that College of Science and Engineering alumni have founded more than 4,000 active companies worldwide that employ 551,000 people and generate annual revenues of $90 billion.

“Our University of Minnesota College of Science and Engineering alumni, faculty and students have a long history of innovation that leads to business development.”

In our cover story “Putting Knowledge to Work,” we get an inside look at a few of these alumni success stories. We see how these entrepreneurs and innovators were willing to take a risk to win big. For many of them building a business from the ground up had its setbacks, but with a good idea and perseverance they found a way to achieve success in new industries, such as mobile power solutions and Internet search engines, to long-standing industries, such as mining and air conditioning.

That drive for success in business starts early for many of our students. In the story “Fire and Rain,” we profile two groups of students who have used their education and business acumen to start companies while still finishing their degrees. Programs such as the University of Minnesota’s Acara Challenge and the statewide Minnesota Cup provide a support and framework to help the students build skills and support for their startup. They are able to take what they learn in the classroom and apply it directly in the business world.

Our College of Science and Engineering faculty are also turning research into successful business ventures. Over the past five years, research by College of Science and Engineering faculty and staff has generated 403 intellectual property disclosures, 129 patents, and nine startup companies. Universitywide, licensing agreements produced more than $45 million for the University last year and University discoveries have launched 46 companies over the last six years.

In our story “Research Gets Down to Business,” we profile four faculty whose research has garnered interest in the marketplace.

Our faculty and students won’t stop there. New facilities will continue to drive innovation at the University. This summer, we opened a new Medical Devices Center in the Mayo Building on campus. The new state-of-the-art, 8,000-square-foot Medical Devices Center facility replaces a previous facility that opened in 2008 in the Shepherd Labs building. Over the last five years, the center’s innovation fellows have filed 120 invention disclosures. Based on these invention disclosures, the University has filed 58 patent applications.

Our new Physics and Nanotechnology Building will also open by the end of the year, creating many new opportunities and business partnerships in the growing field of nanotechnology and strengthening our connections to hundreds of business partners.

Innovation is alive and well at the University of Minnesota. With passion, hard work, and maybe a little luck, we are confident that the next business idea is right around the corner.
Recommended 
Extras 
on the Web

To see these videos and more featuring College of Science and Engineering faculty, students, and alumni, visit our page on YouTube at [www.youtube.com/umncse](http://www.youtube.com/umncse).

### Brain cap research: Mind over mechanics

Using brain-computer interface technology pioneered by biomedical engineering professor Bin He, student researchers demonstrate how they can steer a flying robot around a gym with only their thoughts.

### U of M triclosan research

University civil engineering professor, Bill Arnold discusses his latest research that found high concentrations of triclosan, the primary chemical in antibacterial soaps, in Minnesota lakes.

### Statistical molecular thermodynamics

Christopher Cramer, University chemistry professor, promotes the class he is teaching as part of the free interactive learning experiences being offered by the University of Minnesota.

### Steve Blank: 2013 CSE commencement speaker


### UMN Energy and U Show

Explosions, flames, rock music, and screaming gummy bears—they’re all part of a unique and fun College of Science and Engineering outreach program that aims to interest young people in science.

### Robotics research: Scouting the future

Nikos Papanikolopoulos, University computer science and engineering professor, talks about how robots are changing how SWAT teams and military units are conducting search and rescue.

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University of Minnesota research shows Adélie penguin colony benefiting from climate change

ACCORDING TO A NEW STUDY, led by the University of Minnesota Polar Geospatial Center, Adélie penguins may actually benefit from warmer global temperatures—a stark contrast to some other polar species.

The first-of-its-kind research, published in the journal *PLOS One*, provides key information affirming hypothetical projections about the continuing impact of environmental change.

Scientists from the United States and New Zealand used a mix of old and new technology in order to make their conclusions. They studied a combination of aerial photography beginning in 1958 and modern satellite imagery from the 2000s to study the population size of the Adélie penguin colony on Antarctica’s Beaufort Island.

The images revealed that the penguins actually increased in numbers as the ice fields retreated between 1958 and 2010. In fact, the number of breeding pairs rose from 35,000 to 64,000, constituting an overall population increase of 84 percent. At the same time, the average summer temperature in the area increased about half a degree Celsius per decade since the mid-1980s.

In addition to the overall population growth, researchers saw an increase in population density within the colony as it filled in what used to be unsuitable habitat covered in snow and ice. They also found that the emigration rates of birds banded as chicks on Beaufort Island to colonies on nearby Ross Island decreased after 2005 as available habitat on Beaufort increased, leading to altered dynamics of the population studied.

“This research raises new questions about how Antarctic species are impacted by a changing environment,” said Michelle LaRue, the paper’s co-author and research fellow at the Polar Geospatial Center. “This paper encourages all of us to take a second look at what we’re seeing and find out if this type of habitat expansion is happening elsewhere to other populations of Adélie penguins or other species.”

Adélie penguins are common along the southern Antarctic coast. Smaller than their Emperor penguin counterparts, they stand about 46 to 75 cm [18 to 30 inches] when upright and weigh about 4.5-5.4 kg (10-12 pounds). The Adélie penguin lives only where there is sea ice but needs the ice-free land to breed. Breeding pairs produce on average one chick per year and return to the same area to breed if conditions haven’t changed.

In the future, researchers plan to use additional satellite imagery to look at other Adélie penguin populations to help understand the dynamics and environmental factors that influence regional populations.

A study by the University of Minnesota Polar Geospatial Center reveals that the population size of an Adélie penguin colony on Antarctica’s Beaufort Island increased 84 percent as the ice fields retreated between 1958-2010. The biggest change has occurred in the last three decades.

U research shows contributions to Wikipedia declining

ACCORDING TO A NEW STUDY by University computer science researchers, the number of active Wikipedia contributors has steadily dropped since 2007.

The study, recently published in *American Behavioral Scientist*, blames the decline on Wikipedia’s strict and efficient editing protocol, which discourages newcomers.

When Wikipedia’s popularity exploded in 2005, the community of volunteer editors reacted to the massive growth in contributions by creating software to automate the removal of common types of vandalism and added structure to the community’s rules.

The researchers said that while Wikipedia has sought to root out less competent editors, its rules have also discouraged “desirable newcomers” who get discouraged when their contributions get deleted.

“Open collaboration systems, such as Wikipedia, need to maintain a pool of volunteer contributors to remain relevant,” said Aaron Halfaker, the study’s lead author and a computer science Ph.D. student. “Wikipedia was created through a tremendous number of contributions by millions of contributors. However, recent research has shown that the number of active contributors in Wikipedia has been declining steadily for years and suggests that a sharp decline in the retention of newcomers is the cause.”

“Wikipedia has changed from the encyclopedia that anyone can edit to the encyclopedia that anyone who understands the norms, socializes himself or herself, dodges the impersonal wall of semi-automated rejection, and still wants to voluntarily contribute his or her time and energy can edit,” Halfaker said.
University ads promote perfect union with local corporations

THE UNIVERSITY OF MINNESOTA boasts a number of thriving partnerships with Fortune 500 companies, many located in the Twin Cities. Three such partnerships— with Land O’ Lakes, 3M, and Boston Scientific—are featured in a series of new radio ads, as well as print ads.

The ads feature examples of the University and business working hand-in-hand to address Minnesota’s challenges and drive innovation.

Each dollar invested by these companies in the University yields great returns for Minnesota. For example, engineering faculty have developed a 3D visualizer that Boston Scientific scientists are using to help design their life-saving heart devices, and engineering students are collaborating with 3M scientists to enhance the capabilities of the latest solar energy materials.

“There’s a definite strong connection between the University, the research that goes on, the commercialization of that research, and the broader health of the business community— specifically the science- technology-based businesses. A very direct and strong link,” said Margaret Anderson Kelliher, president and CEO of the Minnesota High Tech Association (MHTA).

Corporations provide gifts to support scholarship funds for U students, and they offer another valuable commodity—internships. The students they help often become their future workforce.

“We know that companies talk about the need for strong talent, and the U of M is one of the major generators of technicians and scientists— especially at the master’s and Ph.D. levels,” Kelliher said.

“You really can’t walk through the halls of a company without—within a few steps—touching someone who has their degree from the University of Minnesota,” she adds.

It’s a win-win situation.

U receives grant to develop next generation microelectronics

THE UNIVERSITY OF MINNESOTA was awarded a $28 million grant over five years to lead a new national research center focused on developing the next generation of microelectronics.

The grant was awarded by the Semiconductor Research Corporation, a global research collaboration of private companies, universities and government agencies, and the Defense Advanced Research Projects Agency (DARPA). Minnesota is one of only six lead universities to receive funding through the Semiconductor Technology Advanced Research network (STARnet) initiative aimed at supporting continued growth and leadership of the U.S. semiconductor industry.

The new Center for Spintronic Materials, Interfaces, and Novel Architectures (C-SPIN) will bring together top researchers from across the nation to develop technologies for spin-based computing and memory systems. Unlike today’s computers, which function on the basis of electrical charges moving across wires, the emerging spin-based computing systems will process and store information through spin, a fundamental property of electrons.

“The incredible ability to scale semiconductor technology, an electron-charge-based technology, has led to the information revolution of the past half-century,” said C-SPIN’s director Jian-Ping Wang, a University of Minnesota professor of electrical and computer engineering.

“However, today’s semiconductor technology is reaching its fundamental limits in terms of density and power consumption. Spin-based logic and memory based on the hybridization of magnetic materials and semiconductors have the potential to create computers that are smaller, faster and more energy-efficient than conventional charge-based systems.”

“This new center is just one example of how research at the University can help boost the economy locally and globally,” said University President Eric Kaler. “This center will bring together the nation’s best minds in spintronics to push the boundaries of research and develop new discoveries that will benefit all of us.”

C-SPIN is headquartered at the University of Minnesota-Twin Cities and will fund research for 31 leading experts from 14 universities working in six scientific disciplines. C-SPIN will also fund research from more than 60 doctoral and post-doctoral students and host industry researchers-in-residence.

Structural Engineering Lab renamed in honor of Professor Galambos

THE DEPARTMENT OF CIVIL ENGINEERING’S Structural Engineering Laboratory has been renamed “The Theodore V. Galambos Structural Engineering Laboratory,” in honor of Professor Emeritus Theodore Galambos’ more than 40 years of ground-breaking contributions to the University and civil engineering.

Galambos joined the department in 1981 and retired in 1997. He continues to publish scholarly articles, give presentations around the world, and participate on code writing committees. His research areas are the reliability of structures, structural design standards, and stability of steel structures. He has authored more than one hundred publications on various aspects of structural engineering, and participated in almost every major specification committee for metal structures in the U.S.
NOvA lab records first 3D images

THE FIRST FINISHED SECTION of the NuMI Off-Axis Electron Neutrino Appearance (NOvA) far detector has recorded its initial three-dimensional images of a subatomic particle. It’s part of research that scientists hope will give them a better understanding of the universe.

“These initial images are a testament to the innovation and ingenuity of University faculty and collaborating researchers around the globe,” said Marvin Marshak, laboratory director and professor of physics and astronomy. “We are thrilled to receive these first tangible results and are excited for the remarkable research the NOvA detector will allow in the near future.”

Housed near Ash River, Minn., the NOvA far detector is in a first-of-its-kind laboratory of the University’s School of Physics and Astronomy. University students and faculty at the Minneapolis-based NOvA Module Laboratory are constructing the detector’s more than 10,000 modules.

The 14,000-ton NOvA particle detector is being built to study neutrinos—subatomic particles that can help researchers discover how the universe was formed and how it will change.

The completed section of the detector is about 12 feet long, 15 feet wide and 20 feet tall. It catches cosmic rays—particles produced by a constant rain of atomic nuclei falling on the Earth’s atmosphere from space—at a rate of 3,000 rays per second. When cosmic rays pass through the NOvA detector, they leave straight tracks and deposit well-known amounts of energy—a perfect tool for calibrating a new detector.

The NOvA laboratory in Ash River is no ordinary building. It contains a shielded detector hall that is 280 feet long and 67 feet wide with a 70-foot ceiling. Attached to the hall is a 72-foot-long assembly area and a 124-foot-long loading dock area with space to house dual overhead cranes. The block pivoter, weighing more than 750,000 pounds, will be used to move the more than 12,000 modules that comprise the neutrino detector into position.

More than 250 University undergraduates and six full-time staff are currently employed at the module factory. The finished NOvA far detector will be constructed from individual modules weighing 1,100 pounds each. All told, the detector will comprise more than 11 million pounds of PVC and rank as the world’s largest PVC structure. The entire detector will measure more than 200 feet long, 50 feet wide and 50 feet tall.

“Neutrino research is a journey to discover how our universe began,” Marshak said. “To actually construct the device that will enable this discovery is a special opportunity for our students.”

An international collaboration, the $283 million NOvA experiment involves 169 scientists and engineers from 34 global universities and laboratories. When the detector in Minnesota is completed, physicists will use it to explore the mysterious behavior of neutrinos, fundamental building blocks of matter that are thought to have originated in the Big Bang.

“It’s taken years of hard work and close collaboration among universities, national laboratories and private companies to get to this point,” Fermi laboratory director Pier Oddone said. Later this year, Fermilab, outside Chicago, will start sending a beam of neutrinos 500 miles through the Earth to the NOvA detector in northern Minnesota. When a neutrino interacts in the NOvA detector, the particles it produces leave trails of light in their wake. The detector records these streams of light, enabling physicists to identify the original neutrino and measure the amount of energy it had.

The NuMI Off-Axis Electron Neutrino Appearance (NOvA) lab near Ash River, Minn. has recorded its first images. This 3D image shows a cosmic-ray muon producing a large shower of energy as it passes through the NOvA far detector.
U researchers control flying robot with only the mind

Researchers in the University’s College of Science and Engineering have developed a new noninvasive system that allows people to control a flying robot using only their mind. The study goes far beyond fun and games and has the potential to help people who are paralyzed or have neurodegenerative diseases. The study was published in IOP Publishing’s Journal of Neural Engineering.

“Our study shows that for the first time, humans are able to control the flight of flying robots using just their thoughts sensed from a noninvasive skull cap,” said Bin He, lead author of the study and biomedical engineering professor. “It works as good as invasive techniques used in the past.”

A brain-computer interface technology pioneered by Bin He, professor of biomedical engineering, may help people who are paralyzed regain mobility and independence some day.

He said this research is intended to help people who are paralyzed or have neurodegenerative diseases regain mobility and independence. “We envision that they’ll use this technology to control wheelchairs, artificial limbs or other devices,” He said.

Five subjects took part in the study. Each were able to successfully control the four-blade flying robot, also known as a quadcopter, quickly and accurately for a sustained amount of time.

The noninvasive technique, called electroencephalography (EEG), is a unique brain-computer interface that records electrical activity of the subjects’ brain through a specialized, high-tech EEG cap fitted with 64 electrodes. The brain-computer interface system works due to the geography of the motor cortex—the area of the cerebrum that governs movement. When we move, or think about a movement, neurons in the motor cortex produce tiny electric currents. Thinking about a different movement activates a new assortment of neurons. Sorting out these assortments laid the groundwork for the brain-computer interface used by the University researchers, He said.

To view a video of student researchers demonstrating the brain-computer interface technology, visit YouTube.com/umnCSE and search for “Mind Over Mechanics.”

Davidson receives national energy award

University Professor of Mechanical Engineering Jane Davidson has received the American Society of Mechanical Engineers (ASME) Frank Kreith Energy Award for her research on solar systems for residential buildings and solar thermochemical cycles to produce fuels.

Davidson, director of the University of Minnesota's Solar Energy Laboratory and Ronald L. and Janet A. Christenson chair of renewable energy, was also honored for contributions as an exemplary educator in renewable energy and for shaping solar energy research and policies at the national and international level.

The award honors an individual for significant contributions to a secure energy future with particular emphasis on innovations in conservation and/or renewable energy.

Before coming to the University of Minnesota in 1993, Davidson was a faculty member at the University of Delaware, Newark, and the Colorado State University, Fort Collins; and held engineering positions at the Oak Ridge National Laboratory, Tennessee, and the Research Triangle Institute, North Carolina.

Current areas of research include solar energy systems for residential buildings and solar thermo-chemical cycles to produce fuels. In 2011, she and her colleagues inaugurated the first indoor concentrating solar simulator in the United States. It is used to test prototype solar reactors. In the conduct of her research, she has been the major advisor of 26 doctoral and 49 master’s degree students.

To learn more about Davidson’s research, view a video at z.umn.edu/davidsonvideo.

Dean Steven Crouch elected to National Academy of Engineering

STEVEN L. CROUCH, professor of civil engineering and dean of the College of Science and Engineering, was recently elected to the National Academy of Engineering (NAE).

Among the highest professional distinctions accorded to an engineer, academy membership honors those who have made outstanding contributions to “engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature,” and to the “pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education.”

“This is a tremendous honor for a deserving researcher, a dedicated educator, and a great leader,” said University President Eric Kaler. “Dean Crouch’s election to the National Academy of Engineering is a testament to his deserved standing as a true leader in his field. We are proud of his career and of his leadership.”

Crouch is recognized by the NAE for his contributions to simulation methodology for the behavior of fractured rock masses.

Crouch’s research focuses on numerical modeling of problems in solid mechanics using boundary integral equation methods. His early research dealt with the stability of underground mine openings. More recently, he has studied numerical stress analysis techniques for fiber-reinforced and particulate composite materials. In the mid-1970s he developed a special numerical method called the displacement discontinuity method, a widely used tool for solving problems ranging from crack propagation in elastic solids to the design of underground mining excavations in jointed and faulted rock.
Entrepreneurs and gamblers have at least one thing in common: they’re willing to take risks. Sometimes those risks are calculated. Sometimes they’re based on nothing more than gut instincts. But the entrepreneur who takes the right chances—like the gambler who bets everything—stands to win big.

Alumni are among those who have bet the house at one point in their life—launching businesses on a shoestring, and investing their careers in technologies they felt could change the world. Collectively, alumni in the College of Science and Engineering have founded more than 4,000 active companies located worldwide, employing 551,000 people and...
generating annual revenues of $90 billion. In Minnesota alone, they have founded 2,600 active companies that employ more than 175,000 and generate about $46 billion in annual revenues.

Their experiences, like their backgrounds, vary considerably. But such differences matter little when you look for the common thread in their tales: all of them took risks and hard work to transform a great idea into a viable business. The five College of Science and Engineering graduates profiled here saw their education pay off.

Harold Hamilton: Listening Is Key

Even as a kid, Harold Hamilton (EE M.S. ’72) showed a knack for knowing how to fix things. His father operated a ranch in the Sand Hills region of Nebraska, and when the wheel came off a tractor or an engine began to sputter, Hamilton would roll up his sleeves and figure out how to remedy the problem. “I was good at repairing things,” Hamilton said.

Today, as the founder and president of Micro Control Company, Hamilton is still problem solving—but the challenges involve management, marketing, finance, and quality control, as well as technical know-how. At Micro Control’s main plant in Fridley, Minn., 170 employees test computer chips using a microprocessor-controlled test system that Hamilton invented in 1973—the first in the industry. The company’s customer list includes such high-profile names as Samsung, Qualcomm, Toshiba, and Hitachi.

Hamilton’s skills at fixing things proved useful when he was drafted into the Korean War after high school. He spent much of his service aboard destroyers, fixing electronic equipment, and under the G.I. Bill, he ultimately enrolled in the engineering program at the University of Nebraska, earning a bachelor’s degree. A job offer from Control Data brought him to the Twin Cities after graduation. He worked on designing computer systems, completed a master’s in electrical engineering from the University in 1972, and eventually took a job at Memorex. When that company folded, Hamilton decided to launch his own business.

“That was back in the day when computers had multiple motherboards,” Hamilton recalls. “They needed to be tested in a manufacturing environment so I designed a piece of equipment that could do that.”

Supplementing his income from sales with some consulting work, Hamilton managed to get the company off the ground by working hard and keeping costs low. At one point, there was an employee working in almost every room of the Hamiltons’ house in Columbia Heights: a tech in the basement, a software engineer in an upstairs bedroom, and Hamilton—the salesman—working off the kitchen table.

“My wife didn’t mind,” Hamilton said. “She thought it was better than having to move somewhere else.”

Business took off almost immediately, and in 1977, Hamilton moved the company, which became Micro Control, to its current site in Fridley. The firm’s product line has grown in recent years based on customers’ needs. In fact, listening to customer feedback and responding accordingly has been key to the company’s success, Hamilton said.

“The first thing I do every morning when I get to work is this: I walk down the hall and talk to the people working on sales with customers,” Hamilton said.

Aspiring entrepreneurs would do well to heed Hamilton’s advice. “Most of the ideas we get for new products come from our customers,” he added.

Jeff Dean: Google’s Unsung Hero

You probably haven’t heard of Jeff Dean. But type his name into a search engine like Google and you’ll quickly discover that Dean (CSci ’90) is a legend in the tech world—the software engineer who mastered many of the behind-the-scenes products that have helped his employer, Google, dominate the Internet.

When Dean was young, his parents—a tropical-disease researcher and a medical anthropologist—moved the family frequently. But from the fifth to 10th grade, Dean attended schools in the Twin Cities.

“At Google, our work gets used on a daily basis by about a billion people.”
“When it came time to look for colleges, the U of M seemed like a natural fit,” he said. “I enjoyed my time in Minneapolis and the school had a good computer science program, which is what I wanted to study. I added an economics major, since I acquired an interest in that subject after taking a few classes.” He also met his future wife, Heidi Hopper, who also graduated from the University with a bachelor’s in psychology in 1990, during freshman year.

Dean spent much of the 1990s completing a Ph.D. in computer science at the University of Washington and working at DEC/Compaq’s Western Research Laboratory, where he focused on profiling tools, microprocessor architecture and information retrieval. In 1999, however, Google came calling.

Dean was initially tasked with putting together an ad system for the company’s growing search-engine business. But as traffic grew, there was increasing need for speed. Dean took a lead role in developing tools that allowed Google to digest large sets of data more and more quickly. He was also instrumental in building MapReduce, BigTable, Spanner, and other systems that have helped Google stay ahead of competitors.

Dean currently works in the company’s systems and infrastructure group. “I really enjoy the work I do at Google for three main reasons,” he said. “First, the set of problems we work on here is incredibly broad, spanning many different areas of computer science (and other fields as well). Second, I have fantastic colleagues, and they often have different areas of expertise than my areas of knowledge. Third, as a software engineer, one of the things you strive for is for your work to be relevant and useful. At Google, our work gets used on a daily basis by about a billion people. That’s very satisfying.”

Most mornings, Dean joins a small, ever-shifting group that gathers around a coffee machine at Google to make espresso and socialize. “It’s almost like an assembly line,” Dean said. “I usually steam the milk, another person operates the grinder, and another brews the espresso....”

As the coffee is made, they chat about their families and discuss technical topics. For Dean, that kind of idea sharing and collaboration is what has kept Google nimble and entrepreneurial in nature, even as it has grown into a global giant. “Some of us have been working together for more than 15 years,” Dean said. “We estimate that we’ve collectively made more than 20,000 cappuccinos together.”

Jason Xiangbing Li: Building Better Batteries

Jason Xiangbing Li didn’t move to California in the mid-1990s so he could live in the center of the tech universe. He relocated there because his wife, Ling Zhuang (CSci, M.S. ’95), landed a job at the semiconductor-equipment maker Applied Materials. “Since it was a better place for her,” Li said of his

Jason Xiangbing Li (ChemE, Ph.D. ’96) built Tenergy, Inc., located in Fremont, Calif., from the ground up. The company provides battery solutions for products used in medical devices, consumer electronics, power storage, transportation, data storage and military.
decision not to pursue a typical chemical engineer’s job at Proctor & Gamble or ExxonMobil. “I joined her in Silicon Valley.”

The decision proved life changing for Li (ChemE, Ph.D. ’96). Initially, he took a job with Applied Materials, learning the ins and outs of product development. But in January 2004, after completing an MBA at the University of Pennsylvania, Li decided to go out on his own. He launched Tenergy, Inc., which provides total mobile power solutions for products used in medical devices, consumer electronics, power storage, transportation, data storage, and the military. The company, headquartered in a 50,000-square-foot facility in Fremont, Calif., employs nearly 100 people.

While many of the company’s customers are located nationwide, Li likes being based in the Silicon Valley. He’s grown fond of the place—and the pace. “I get to witness the rapid technical innovation and creation of wonderful products,” Li said. “You see how new companies started small and grew up to be the largest in the world, like Hewlett-Packard, Intel, Yahoo, Google, Facebook. And you feel these dreams are attainable in real life…. Life and work in California is fast paced and a higher percentage of people seek higher risk with their career for the growth opportunities.”

Li, a native of southern China, and Ling, who grew up in Beijing, met while they were undergraduates at Tsinghua University. After obtaining a bachelor’s degree in materials science and a minor in electrical engineering, Li applied to a number of graduate schools in the United States and eventually accepted a scholarship from the University of Minnesota’s Department of Chemical Engineering and Materials Science.

In 1992, he and Ling moved to Minnesota to start graduate programs. “I am fascinated by physics and chemistry and I like to be intellectually challenged,” Li says of his affinity for engineering. “I also like to create products that solve problems in life.”

Much like the tech world itself, the world of batteries is evolving quickly—and our company is challenged to keep up with increasing demand for more mobile power, says Li. “We have become a significant player in the rechargeable battery market, and are constantly innovating in such areas as battery technologies, chargers, power components, and protection circuit modules,” he added.

Building a business from scratch hasn’t been easy, but Li believes his education and background have contributed to his success. He also hopes he can be an inspiration to other young graduates.

“The thinking focus of an engineer and an entrepreneur are very different,” he said. “An engineer is tasked with solving specific technical problems. An entrepreneur is focused on identifying and meeting market needs with innovative and competitive products or services. Combining the skills and qualities of both, with the right support, ensures ideas do not just remain as dreams but become real, viable businesses that bring good things to life.”

Larry Lehtinen: A Life in Metal
You might say mining is in Larry Lehtinen’s blood. His great grandfather, who emigrated from Finland, and Ling, who grew up in Beijing, met while they were undergraduates at Tsinghua University. After obtaining a bachelor’s degree in materials science and a minor in electrical engineering, Li applied to a number of graduate schools in the United States and eventually accepted a scholarship from the University of Minnesota’s Department of Chemical Engineering and Materials Science.

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mines around Tower, Minn., which might explain his lifelong affection for the Iron Range, where he grew up and still lives.

Lehtinen (Mineral Eng., ’77, M.B.A. ’83) is the CEO and chairman of Magnetation, Inc., which is based in Grand Rapids, Minn. The company is devoted to “smart mineral recovery” using a patented process that facilitates the removal of iron ore from mining tailings—effectively turning waste material into a profitable product. Lehtinen bought the company as a faltering startup in 2008. It now employs roughly 250 people at operations located in Grand Rapids, Keewatin, and Bovey—all in Minnesota—and at its newest plant in Reynolds, Ind. The company is on pace to employ 500 people with $500 million in revenue by the end of next year.

“I like the tangible things we do—mining, processing, and watching the physical stages that occur,” Lehtinen said of his work. “It’s very satisfying to see things go from a napkin sketch to an actual finished product.”

Lehtinen was first introduced to the mining industry shortly after high school, when he landed a summer job with the Department of Natural Resources, working in the minerals office in Hibbing, Minn. The DNR collected samples from around the region, looking for gold and base metals like copper or nickel. Lehtinen worked in the chemical lab, as well as out in the field. “It sounds fancy, but I was the grunt digging holes,” he jokes.

The job, however, piqued his interest, and after obtaining a bachelor’s degree in mineral engineering, Lehtinen went to work as a mining engineer for Inland Steel. He quickly rose through the management ranks, becoming a plant operations manager by the age of 32. “I mastered that and got a little bored,” he admits.

He tried developing a software company on the side (“That was my first foray into entrepreneurial activity”), but soon realized his passion remained in mining. In 2001, Lehtinen launched his own company with seed capital from the Iron Ranges Resources & Rehabilitation Board: Mesabi Nugget, in Hoyt Lakes, Minn., which produced iron nuggets from ore and remains in business today. The biggest challenge of running a business as a sole proprietor, he says, was waiting for customers and investors to respond. “One guy can move pretty fast, but these companies move pretty slow,” he said.

In May 2007, he sold off his interest in Mesabi Nugget and bought Magnetation. “The company intrigued me because I’d worked as a mineral-processing engineer on magnet separation when I was younger,” Lehtinen said. “The thinking at the time was that you couldn’t do anything with the discarded hematite because it’s nonmagnetic. But the reality is, it’s faintly magnetic.”

Prem Jain: India’s Air Conditioning Expert

Prem Jain (ME, M.S. ’60, Ph.D. ’67) is considered the “father of air conditioning” in India. His firm, Spectral, has worked on hundreds of projects across India over the decades.
Today, Jain is not only a graduate and an ardent fan of the University of Minnesota—"a wonderful place" he says—he is also one of the leading experts on air conditioning in India. In 1980, he founded the Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE). His firm, Spectral, established the same year, has worked on hundreds of projects across India over the decades, and Jain himself has personally consulted on projects to rework air conditioning at India’s presidential palace and the Office of the Prime Minister.

Jain credits two people with putting him on this path to expertise and renown. First, his mother. “She wanted me to get the best education there was—and when she found out it was better in the U.S., she insisted I go to school there,” he said. Secondly, his mentor, Dr. James Threlkeld, a University professor of mechanical engineering. “He was a legendary figure in the world of air conditioning,” Jain said.

Threlkeld had a passion for engineering—and air conditioning—that was infectious. Jain remembers one class in which the professor insisted that his students crawl through ductwork so they could understand how air moved.

“Nowadays, when Jain instructs students at the school of architecture at Delhi University, he tries to get his students to think the same way. While he doesn’t insist that anyone wriggle through ductwork, he does require his students to visit actual building sites that Spectral is working on to examine how projects are put together.

“I tell them, ‘Think of yourself traveling in a bubble. How do you move through the system?’” he said. “They learn exactly what to do in real life. It’s an experience you can’t get from reading a book.”

Two years ago, Jain merged Spectral with AECOM, a global provider of technology and management support solutions, and today he serves as chairman of AECOM India. He believes the entrepreneurial spirit that led him to America and ultimately back to Delhi to start his own company still exists and offers his advice to fledgling entrepreneurs.

“Aim for the stars,” he said. “Be true to your profession. Don’t make small targets. Set large goals that seem almost unattainable—and then achieve them.”
It takes hard work and guts for anyone to transform a great idea into a viable business, but even more so if you’re a full-time student in a rigorous degree program.

Campus-born success stories like Bill Gates, who turned his passion for computer programming into Microsoft, and Mark Zuckerberg, who was the brains behind the social network Facebook, are just two examples. Both were still college students when they began transforming their ideas into real businesses.

More college students today, including those in the College of Science and Engineering, are using what they learn in the classroom to follow their dreams and take control of their careers. Driven by a desire to find personal fulfillment along with a paycheck, these students have emerged with new ideas and business plans based on social responsibility and their own passions, interests, and ideals.

While many College of Science and Engineering students may have innovative ideas, often they aren’t sure how to get them off the ground. They needn’t look too far. Several programs at the University of Minnesota offer support and encouragement in helping to fulfill their dreams. Here are two of their stories.

**Fire Dancers**

When College of Science and Engineering students, Mac Cameron, Hunter Dunbar, and Charles Brown met more than three years ago in the University student group, Tesla Works—founded by Cameron and Brown—starting a company was something they didn’t envision. Their goal was to form friendships with other like-minded students who had an interest in working on projects with a technical twist. Since founding the group, they have not only started a company called Zmach, they have brought something new to the fireplace market—flames that move to music.

Fittingly named “FireWave,” the inspiration for the fireplace came from a classic experiment, known as a Rubens’ tube that Cameron, a senior majoring in physics, demonstrated for one of his physics classes.

Invented by German physicist Heinrich Rubens in 1905, the Rubens’ tube is an antique physics apparatus that graphically shows the relationship between sound waves and air pressure, like a primitive oscilloscope. Fairly easy to construct, a length of pipe is perforated along the top and sealed at both ends. One end of the pipe is attached to a small speaker, the other to a supply of propane gas. The pipe is then filled with gas and lit.

“As soon as you light the gas, you see uniform flames rising from the tube. When sound is applied through the speaker, pressure changes within the
“tube,” said Brown, who is also majoring in physics. “You begin to see the varying sound wave lengths created in the series of flames, creating a stunning effect. The flames literally move in time to tunes ranging from jazz to dubstep.”

**Minnesota Cup offers more than prize**

Things started falling into place soon thereafter. Thinking they could create something tangible for the Minnesota Cup competition, the Zmach team set out to build an innovative fireplace.

The Minnesota Cup, now in its ninth year, is the largest statewide new venture competition in the country, and has drawn more than 7,000 participants since it began in 2005. Divided into six divisions, the competition seeks out, supports, and celebrates Minnesota’s most innovative and promising young entrepreneurs and serves as an ideal launching point for ambitious innovators.

While other students were traveling abroad and taking a break from courses, the Zmach team spent most of the summer of 2011 fashioning a sleek, modern-looking fireplace out of sheet metal using the dancing flame technology.

“We thought it was something that would dazzle people,” said Dunbar, who has since switched majors from physics to engineering and management. “Everyone who sees it thinks it’s awesome and cool. Most say they would like one of their own.”

Zmach’s work and instincts paid off. The team received third place honors in the student division at the 2012 Minnesota Cup.

Scott Litman, co-founder of the competition, says that while winning the competition can net prize money, it’s a pretty minor reward, compared to the other benefits.

“More important are the opportunities for exposure, advice, networking, and investment that open up to the competitors,” he said.

“We’ve been able to network with some very influential people through the competition, people who have helped with legal counsel and business tips,” Cameron said.

**Future plans**

Thus far, the team has secured a provisional patent and they are planning to commercialize the technology by licensing it to fireplace manufacturers and/or selling it to retail stores offering novelty products.

The Zmach team says they’ve learned a lot in the process as they continue to refine the fireplace, which includes using color inserts that would add another novel dimension.

“The fireplace industry represents more than one billion dollars annually,” said Dunbar. “We’re optimistic that this blend of art and science in a simple design will deliver warmth and vibrant energy to any social or private space.”

“While school has been our number one priority, we’re doing all we can to make this a profitable venture,” said Cameron. “A little luck will go a long way to help align the stars in our favor.”

For more information about Zmach and the FireWave technology, visit [www.zmach.com](http://www.zmach.com).
Rain Makers

When Sri Latha Ganti signed up for the Acara Challenge, she wanted to help change the world. The course and competition sponsored by the University of Minnesota Institute on the Environment helps budding entrepreneurs develop practical business solutions addressing global, societal, and environmental challenges. After all, she had seen firsthand the problems of poverty, malnutrition, and poor irrigation methods, which face many subsistence farmers in her native land of India.

“I have always been passionate about helping people,” said Ganti, who received her master’s degree in electrical engineering from the College of Science and Engineering in 2011. “When I first heard about the Acara Challenge, it sounded so interesting. I felt it could pay off in many ways.”

Nearly three years later, Ganti and her business partner, Steele Lorenz, a 2010 Carlson School of Management graduate, are beginning to see the fruits of their labor, which began as a project in the 2010 Acara Challenge. Their start-up company, MyRain, which has been fully operational since June 2012, is starting to make money. The company offers agricultural equipment, including drip irrigation systems, to rural farmers in developing countries.

Creating a business plan

In 2010, Ganti and Lorenz were among five University of Minnesota students who were paired up with a team of students from the Indian Institute of Technology in Roorkee. Together the two teams developed a business plan for their Acara Challenge project—MyRain.

Their objective was to help small subsistence farmers—those farming from one to five acres—in India improve their crop yields and make their farms more sustainable through a cost-effective, and simply designed drip-irrigation kit.

“In many parts of rural India, small-plot farmers rely on flood irrigation, an approach that takes so much precious water, strips nutrients, requires tons of fertilizer and often stunts growth and yields,” said Ganti, who now serves as chief operating officer of MyRain.

“By implementing drip irrigation, a system that efficiently delivers water directly to the roots of crops through perforated tubes, rural farmers can increase water and fertilizer efficiency by 20 to 50 percent and increase yields by 30 to 100 percent,” she said.

Drip irrigation was originally developed for large industrial farms. Recently, the systems have been scaled down and simplified for smaller farms. Although these scaled-down systems exist, the farmers aren’t benefiting because they lack awareness and accessibility. Plus, they can’t afford the product. The same is true for other agricultural products.
“We’re working to increase awareness, accessibility and affordability from two aspects,” said Ganti. “First, we’re developing a network of dealers who carry our products. Secondly, by buying the products directly from the manufacturers, we’re able to provide the product to the farmer at the lowest possible price.”

Ultimately, the MyRain project team was not among the winners in the Acara Challenge. However, Ganti and Lorenz believed so strongly in their project that they have worked nights and weekends for the last three years to refine their mission and develop the company.

Now, as official business partners, they have incorporated MyRain, improved the business plan, and have received initial funding from angel investors.

Launching the future

Lorenz, who serves as CEO of MyRain and is based in Madurai in southern India, has been working to launch the business since June of last year. Ganti works remotely for MyRain on a part-time basis, since she holds a full-time position as a software engineer at Seagate in Minneapolis. They also employ two full-time people in India, an operations manager and an office assistant. In the future, Ganti hopes to join Lorenz in India since most of her family still lives there.

One challenge MyRain has had to face is the way its product is distributed. Because of the foreign direct investment rules in India, the company cannot sell directly to farmers. So they sell through dealers, who could be any tradesperson in the community, from existing shop owners to a plumber.

“We’ve been able to develop an independent dealer network that empowers local entrepreneurs to sell to their friends and families,” Ganti said. The company helps with training, works with local manufacturers, and helps farmers roll out the systems.

“We’ve seen a lot of excitement among the farmers who are using the drip irrigation system,” said Ganti. “Many are asking what additional technologies they can adopt, which opens up further opportunities for our company.”

In addition, they are using their Indian market knowledge to consult with organizations that have a product or product idea and want to expand to India. “We are currently consulting with a Minnesota-based company on marketing their water purification product,” Ganti said.

Even though the future looks optimistic for MyRain, success is not guaranteed. Nonetheless, Fred Rose, executive director of the Acara Institute, says the lessons Ganti and Lorenz have learned are life changing. “Even if they don’t succeed, introducing the drip irrigation system has had a major impact on the lives of many small farmers in India, which they both can be proud of,” he added.

For Ganti, building MyRain has helped her gain new perspectives on what it takes to achieve a successful venture. “Thinking about all the aspects, it’s important to identify problems and needs,” she said. “Once you’ve done that, you can create solutions, which I think we’re doing with our company.”

For more information about MyRain, visit www.myrainindia.com.

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When I first heard about the Acara Challenge, it sounded so interesting. I felt it could pay off in many ways.”

—SRI LATHA GANTI
Research Gets Down to Business

college of science and engineering faculty turn research into successful business ventures

Research often starts with a passion—finding a cure, making a better product, or creating a more efficient system. Commercializing that research and bringing it to the marketplace is becoming a growing trend among faculty, especially those in the science and engineering disciplines.

Over the past five years, research by College of Science and Engineering faculty has generated 403 intellectual property disclosures, 129 patents, and nine start-up companies.

That’s potentially good news for the economy. “Startups are probably the best way to get disruptive technology commercialized and into the hands of the public,” said Jay Schrankler, executive director of the University’s Office for Technology Commercialization (OTC).

The OTC is responsible for licensing University research for the development of new products and services. Whether the research is licensed to a startup or an established company, the objectives are the same: to benefit the public, foster economic growth, and generate revenue to support future University research and teaching. Last year, licensing agreements produced more than $45 million for the University.

Martin Saar, earth sciences associate professor, has developed an innovative approach to tapping the heat beneath the Earth’s surface which produces renewable electricity far more efficiently than conventional geothermal systems. It also helps reduce atmospheric carbon dioxide (CO₂).
Why so much more activity now? “We are getting a lot more engagement from faculty,” said Schrankler. That may be because the University has started sponsoring five workshops a year to show faculty the process and benefits of commercialization. “They get energized,” said Schrankler. “We’re getting faculty members who say, ‘I want to be part of a startup. I want to contribute this way.’”

University discoveries have launched 46 companies over the last six years. Ten have folded. “Thirty-six of them are still in business,” said Schrankler. The high success ratio is a validation of the criteria the OTC uses to decide whether to try to commercialize a technology. “They’ve raised money, they’re live and they’re viable. For now that’s a good metric,” he said.

Among the University’s most recent startups are four that have licensed technology developed by researchers in the College of Science and Engineering. The stories of these professors and their discoveries follow.

The stories are unique. Some who discover a new technology want to take a big role in the startup that develops. Others are content to spin a company off and get back to their labs. Sometimes the startups show immediate promise. In other cases, they may have to fight to get attention in the market.

But if there are common threads to all startups, they are these: First is a promising idea that can be protected by patent or copyright. And second is the belief the new technology can contribute to a better future.

“At the end of the day, everyone wants to make an impact that improves a lot of our world’s citizenry,” said Brian Herman, University of Minnesota Vice President for Research. “I think that’s what drives many of the academics in an institution. And the commercialization process is what allows that to happen in a very immediate fashion.”

Martin Saar: Mining the Earth for Power

Martin Saar’s process for a pollution-free source of energy emerged several years ago as he and Jimmy Randolph, then a graduate student in Earth sciences, were driving to a field research site in northern Minnesota.

Saar, an associate professor of Earth sciences and holder of the Gibson Chair of Hydrogeology and Geo-fluids, and Randolph were batting about ideas for Randolph’s doctoral project on geothermal energy. They were also discussing an unrelated project on geologic carbon dioxide (CO2) sequestration—a process that pumps this greenhouse gas deep into natural rock reservoirs to keep it out of the atmosphere thereby reducing global warming.

“Then the light bulb went on. We asked ourselves, ‘What happens when you combine these two processes?’” said Saar. “We had a pretty good hunch right then and there that this could be big.”

The idea was something Saar now calls “CO2 plume geothermal system,” or CPG and piggybacks on two industrial processes. The first is geologic CO2 sequestration where CO2 is captured and pumped deep into the ground before it enters the atmosphere.

“This method actually has a negative carbon footprint, thereby rendering conventional coal-fired power plants—from where the CO2 is captured—green.”

—MARTIN SAAR

The technology captures carbon dioxide (CO2) from fossil-fuel-burning power plants and injects it deep into the earth, helping to reduce the chief greenhouse gas that causes global warming and climate change. The bulk of the CO2 becomes permanently stored as a large underground CO2 plume that is naturally heated by Earth’s abundant internal heat.

A small portion of the geothermally heated CO2 is then cycled up to the Earth’s surface through a production well, where the CO2 heat is used to generate electricity. Once used, the cooled CO2 is re-injected back into the Earth to be cycled again.

The second process is “enhanced oil recovery.” Oil companies pump CO2 into partially depleted oil reservoirs to help drive some of the remaining oil to the surface. Electricity to power the pumps is the biggest operating costs of an enhanced oil recovery operation.

Both processes create huge CO2 reservoirs, one to five kilometers below ground surface. Tremendous pressure and temperatures of up to 200 degrees C transform the CO2 into its “supercritical” state. “It has liquid-like density and gas-like viscosity,” said Saar. “CPG is a more efficient way to produce electricity than water-based geothermal power systems,” said Saar. “This method actually has a negative carbon footprint, thereby rendering conventional coal-fired power plants—from where the CO2 is captured—green.”

The CPG system received an initial $600,000 grant from the Institute on the Environment’s Initiative for Renewable Energy and the Environment, which helped to leverage a $1.5 million grant from the U.S. Department of Energy and a $1.9 million National Science Foundation grant. Now licensed to startup company Heat Mining Company LLC, located in Rapid City, S.D., Saar is co-founder and the chief scientific officer.
Generating power from this technology would produce significant revenue—about $5 million a year for a single 10-megawatt turbine, depending on the cost of the electricity. Furthermore, multiple CPG installations could be installed. That money would help make carbon capture and storage financially viable and help reduce global warming. Or it could prolong the life of nearly depleted oil reservoirs. “If you get electricity cheaper, then the lifespan of that oil reservoir can be extended,” Saar said.

Placed on a fast track with other green energy patents, the CO₂ plume geothermal technology received a U.S. patent on November 27, 2012. The international components of the patent are currently pending. Heat Mining Company has also filed patent applications for enhanced CPG technology, which will broaden the range of geologic conditions that make economic sense.

Heat Mining Company is promoting the technology on two fronts. First, it is trying to negotiate a pilot project with one of several power plants that are geologically sequestering carbon dioxide to reduce net emissions of this greenhouse gas. The more immediate benefit is being able to produce clean, very low cost electricity at enhanced oil recovery sites in hundreds of existing oil fields worldwide. Heat Mining Company would cover all capital costs to install or operate the CPG system. The participating oil companies would receive 30 percent of the income from the electricity produced, an amount sufficient to provide a $10 to $15 per barrel pricing hedge.

Kenneth Carpenter, Heat Mining Company’s managing partner, says the company hopes to install the first plant this year and to have 15 in place within three years. Capital costs are low, and the infrastructure to carry the power exists at all the sites already. “Technology such as turbines is pretty much off the shelf,” Carpenter said.

“That’s the beauty about it,” said Saar. “It’s one of those things where you don’t have a huge amount of risk in terms of technology because all the components are fairly well known.”

Henry Liu: Developing Smarter Stoplights

It’s probably safe to say that drivers have cursed sitting in line at stoplights ever since the nation’s first electric traffic light was installed in Salt Lake City, Utah in 1912.

Since then, traffic managers have learned how to time lights to smooth the flow of traffic on busy arterial highways. But because traffic data for these kinds of roads is rarely stored or analyzed, traffic rarely moves as fast or as smoothly as it could.

However, now traffic managers have a way to economically record traffic movement. A University of Minnesota scientist has devised his SMART Signal system to measure queue length and traffic speed at stoplights and to analyze it—all without a lot of expensive add-on equipment. The result is a new startup company SMART Signal Technologies that is beginning to market the technology to counties, cities, and other transportation managers to speed traffic and reduce congestion on major roads and highways with signals.

The benefit to drivers—less aggravation, fewer delays, and reduced fuel consumption. “There are all sorts of reasons we have to operate our traffic lights efficiently,” said Henry Liu, the assistant civil engineering professor in the Center for Transportation Studies who developed SMART Signal.

Until now, says Liu, “how we evaluated traffic signal performance has been largely manual effort.” Someone sits at an intersection, counts the number of cars that stop in the queue and times how long they remain at a standstill. Government has to pay someone to do that, and then it has data only for the brief period it sent someone to count cars.

That was state-of-the-art several years ago when the Minnesota Department of Transportation sent...
out a research request for a means to evaluate traffic signal performance using existing infrastructure. “I thought that was an interesting topic,” Liu said.

The “existing infrastructure” of a light-controlled intersection is pretty basic: The light itself. A detector such as an inductive loop imbedded in the roadway near the intersection, and a controller cabinet with circuitry to change the duration of the light when traffic starts to pile up.

To develop his system, Liu installed a laptop computer inside the controller cabinet to receive the information the controller receives about signal timing and passing cars. Liu then developed two algorithms to analyze this data. One estimates queue length. The other estimates travel times through a particular stretch of highway.

“That is very important information for traffic engineering purposes,” Liu said. “It is also important for drivers. If I post this information online, you will be able to see which intersection is congested so you can make the decision you want to avoid that intersection. And if you want to go from point A to point B you can actually estimate your travel time.”

Most importantly, the SMART Signal analysis lets traffic managers know what is happening at their signals, 24/7.

“If we know what’s going on, we know what to do,” said Liu. “Once you know the performance, fine tuning the signal parameters is a lot easier.”

Liu has been testing his SMART Signal system on several highways in Minnesota and California, including Highway 55 in Golden Valley, France Avenue in Bloomington, and Highway 13 in Burnsville. The Minnesota Department of Transportation, Minnesota Local Road Research Board, the University’s Intelligent Transportation Systems Institute, Hennepin County, and the National Cooperative Highway Research Program have provided funds for his research.

SMART Signal Technologies, launched in late 2011, is offering the new technology to highway managers—basically, any city, county, or state. “Anyone who has traffic signals to manage is a potential customer for us,” Liu said.

Max Donath: From Distraction to Coach

Car wrecks kill more U.S. teens aged 15–19 than any other cause, according to the Centers for Disease Control and Prevention. Additionally, drivers under age 20 are nearly four times as likely to have a crash than older drivers.

What are among the causes? Using a cell phone distracts them. A mobile phone was involved 19 percent of the time teen drivers caused a fatal accident.

An app developed by a team of researchers led by Max Donath, mechanical engineering professor and director of the University Intelligent Transportation Systems Institute, has transformed this potential distraction into a tool to coach and monitor teen drivers and alert their parents to driving problems.

“Mechanical engineering professor Max Donath is among researchers who developed DriveScribe, a smartphone app commercialized by Minneapolis-based Drive Power LLC, which is helping to keep the roads safer by acting as a personal driving coach.”
The app gives feedback to drivers if they jam on the brakes, roll through stop signs, or exceed the speed limit. It even alerts drivers to upcoming curves. Data from the drive is stored online so parents can review their teen’s driving performance.

The smartphone app became DriveScribe. The University licensed the technology to the startup company Drive Power, which is marketing the product both to parents of young drivers and managers of corporate fleets.

Work on the project began several years ago, Donath explained. The first prototype, tested in 2006, used a laptop in the car and a separate GPS unit to track the vehicle’s location. “It was certainly not anything that a teenager would want or care to use,” Donath said.

Later efforts used smartphone platforms. In the most recent version, Alec Gorjestani, Michael Manser, and Janet Creaser, researchers in the Department of Mechanical Engineering, worked to develop the kinds of warning and coaching that kids might best respond to.

“We spent a lot of time figuring out what words to use,” Donath said. “We do use a whole host of expressions to tell the teen to slow down, and if the teen doesn’t pay any attention, we warn them that we’ll tell their parents where they are. If they continue to ignore us, we text message the parents where they are and that they’re speeding.”

At the same time, the app blocks calls, email, and texts. “It’s basically taking over the phone,” Donath said.

Donath’s team tested the device with 30 teenage drivers and their parents on the roads around Stillwater. Washington County is among the counties in the state with the highest number of teenage driver fatalities. A researcher rode along with the teen drivers while the parents waited behind. “The idea was to see how the teen reacted to the system, what their impressions were, and how their parents felt about it,” Donath said.

The software project was funded by the Intelligent Transportation Systems Institute, a University transportation center affiliated with the Center for Transportation Studies, with money from the U.S. Department of Transportation and the Minnesota Department of Transportation. After Drive Power licensed the new app, Gorjestani became vice president of technology of the new company.

Donath, however, is happy keeping the new company and the evolving DriveScribe app at arm’s length.

“To be perfectly honest with you, it is not my philosophy for me to leave the University to start a company,” Donath said. Instead, he says he sees himself and the University as a tech incubator.

“We are constantly working on new ideas, and testing them,” said Donath. “The bottom line is that we want to see this technology get out there. But before it can get out there, we have to evaluate these ideas and try them out. So as a research organization, our focus has for a long time been on trying out new ideas, evaluating them, getting feedback, seeing if they really resonate with the users. If they do, we want to see them deployed.”

Michael Tsapatsis: The Power of Membranes

Usually, problems beget solutions. However, sometimes it happens the other way around—a solution appears, and a suitable problem must be found.

That’s the story of Michael Tsapatsis, chemical engineering and materials science professor, and his ultrathin zeolite membranes.

For more than 10 years, Tsapatsis has been trying to fabricate thin layers of zeolites. Zeolites are crystalline minerals of oxygen and silicon. Some occur naturally. Some not. What makes them special is their regular pattern of molecular-sized pores. They are used in industry as catalysts, filters, and adsorbents.

Tsapatsis was trying to figure out how to reduce zeolite crystals to their minimum thickness. For a long time his attempts came to naught as the fabricated sheets disintegrated.

“Slow progress for some time,” Tsapatsis said. “And then suddenly things worked out.”

In a series of three papers recently published in Science, Tsapatsis and his lab team described how they successfully created “layered nanosheets”—just two nanometers, about 10 silicon atoms, thick. In one project, they grew thin crystals into a “house of cards” that maximized the surface area of the nanosheets.

The zeolite nanosheets were lattices with “pores of molecular dimensions which we can control based on the synthesis method,” Tsapatsis explained. “So that’s the innovation—that we make very thin layers and these layers have holes that are regularly sized and regularly arranged in a crystallographic order.”

Now, Tsapatsis is trying to show what they’re good for.

So far he has demonstrated that the nanosheets make effective sieves, able to separate molecules on the basis of pore size. Such a material has potential applications in the chemical and oil industry. Presently, chemicals such as hydrocarbons in fuels are separated through simple but energy-intensive distillation. Tsapatsis’s nanosheet membrane can separate molecules using far less energy than distillation. “Our membranes are not going to necessarily replace distillation,” he said, “but they are going to be coupled with distillation.”
Tsapatsis has demonstrated good results under ideal conditions, separating simple mixtures in small volumes. For example, his nanosheet membranes separate alcohol and water, a useful function in a biorefinery such as an ethanol plant.

Tsapatsis is working with industry to test the nanosheet membranes on complicated mixtures of chemicals with lots of impurities. His lab also just received a federal ARPA-E grant of nearly $2 million to produce his membranes in greater quantities to handle larger volumes.

Meanwhile, the “house of cards” nanosheets appear to have ready application as industrial catalysts to accelerate chemical reactions. Zeolites are already used as industrial catalysts, but reactions proceed slowly as molecules work to the center of the zeolite crystal. By increasing the surface area and exposing the pores to molecules arriving from all directions, Tsapatsis’s house of cards nanosheets promise to work faster and with larger molecules. For example, they turn molecules found in crude oil into gasoline and may be able to boost the efficiency of synthesizing fuels and lower the costs of gasoline and other products.

In early 2012, the University licensed Tsapatsis’s nanosheet technology to startup company Argilex Technologies. Now comes the hard part—convincing investors of the value of zeolite nanosheets. So far, it’s been a tough sell. The applications aren’t necessarily obvious. Nor is the opportunity for a big profit. “Yes, it’s very difficult,” said Tsapatsis. “It is not like a market for a consumer product.”

Meanwhile, the research continues. Tsapatsis is convinced industry will eventually find the value of his zeolite nanosheets. When they do, they will license the technology directly from the University or work through Argilex.

“Argilex increases the options that are available,” he said. “It only increases the flexibility.”
CSE Mentor Program designed to benefit students and mentors

JEREMY MELQUIST, who graduated this past spring with a bachelor’s degree in civil engineering, never expected to receive a job offer when he signed up for the College of Science and Engineering Mentor Program. The reason he chose to participate in the program was to learn whether transportation engineering was the field he really wanted to pursue.

“My mentor set up a tour for me of the MnDOT Materials Lab, where I got to see all the different testing equipment that the Minnesota Department of Transportation uses for pavements and soils,” said Melquist. “During the tour, I was able to talk with a few engineers about their jobs and responsibilities. A few weeks later, one of the engineers called to ask if I needed a job, I could come work for them during the semester!”

Program promotes alumni engagement

Each fall, the College of Science and Engineering Mentor Program matches more than 250 students with industry professionals who are alumni and friends of the college. These relationships provide learning experiences for students outside the classroom, where they have opportunities to gain insight into the working world and get advice on how to be successful young professionals.

For mentors, the relationship allows alumni to remain engaged with the College of Science and Engineering, as well as gain personal and professional rewards by sharing unique workplace and professional experience, which is an immeasurable learning benefit to students.

Julie Skallman (CivE ’76, M.B.A. ’86), a state aid engineer for the Minnesota Department of Transportation, thought about becoming a mentor for five years before she actually signed up.

“I thought, ‘Do kids really want to talk to someone who is as far along in their career as me?’” she asked. “I feel we all need to give back. This is such a simple way to do that. Having now done so, I would absolutely encourage every CSE graduate to do so.”

Mentors and students establish their own schedules

Skallman was paired up with Melquist, and they first met at the orientation event last fall. During that meeting, they developed goals and objectives and established a schedule for how often and how they would meet—in person, via email, or by phone.

Not long after the initial meeting, Melquist contacted Skallman to ask if he could visit her at her office.

“I was surprised at how comfortable he was in his communication skills. Looking back, I was much more reserved at that age. He seems much better prepared for the work world than I was,” Skallman said. “The first time we talked for a couple hours—not just about my experience, but about his hopes and dreams for engineering. That may have been the most important conversation we had because we were able to connect on a personal level.”

Melquist says his mentor provided him with a great deal of insight into the world of transportation engineering. “Students need guidance before entering the workforce for multiple reasons,” he said. “Students want to make sure they choose the right major. Mentors can help to prepare them for their future job and guide them as necessary.”

CSE alumni encouraged to get involved

With her first CSE mentoring experience under her belt, Skallman encourages other CSE alumni to get involved. “The highlight of the year for me culminated at the CSE Mentor Appreciation Dinner. I arrived at the event before Jeremy did. As soon as he saw me, his face lit up and he said, ‘I got a job!’ It was wonderful that he was so excited to share his news with me,” she said.

Look for information about participating in the 2013-14 CSE Mentor Program later this summer. If you have questions, please contact Ann Terry in CSE Alumni Relations at: asterry@umn.edu or 612-626-1802.

Celebrating at the CSE Mentor Appreciation Dinner are [left to right] mentor Julie Skallman (CivE ’76, M.B.A. ’86) and Jeremy Melquist, [CivE ’13]; mentor Mike McFarland (Aero ’86) and Hoa Huynh, electrical engineering student; and mentor Kelton Barr (Hydrogeology M.S. ’78) with Vida Dam, biomedical engineering student, and mentor Rahul Gupta (EE M.S. ’03, BME Ph.D. ’08).
Four CSE alumni receive Outstanding Achievement Awards

THE UNIVERSITY OF MINNESOTA Board of Regents have honored four College of Science and Engineering alumni with the Outstanding Achievement Award (OAA) during the year. The OAA award is given to University of Minnesota graduates who demonstrate unusual and outstanding achievement and leadership. They are:

Arthur J. Coury [Chem Ph.D. ’65]
Biomaterials Executive, Coury Consulting Services

Coury is honored for his outstanding contributions to biomedical device and biomaterials research and development. His prolific scientific work, extensive service to the academic and industrial scientific communities, and selfless mentoring has had a positive impact on innumerable lives.

Coury’s career focus has been on polymeric biomaterials for medical products such as implantable electronic devices, hydrogel-based devices, and drug delivery systems. He has held a number of senior-level biomedical positions at major corporations nationwide. He holds more than 50 patents and has been widely published. Currently, Coury is a biomedical consultant.

Mark W. Kroll [Math ’76, EE M.S. ’83, Ph.D. ’87]
Principal, Mark Kroll & Associates

Kroll is honored for his pioneering accomplishments in the electrical medical device field. He holds more than 270 patents—tops in Minnesota and second in the world for medical devices—which have led to breakthroughs in cardiovascular technology.

A former St. Jude Medical top executive who specializes in electric physiology, Kroll developed ways to shrink implantable cardioverter defibrillators (ICDs). Such devices, now sold by major medical device companies, shock an errantly beating heart back into rhythm. A corporate director of Taser International, Haemonetics, and various private companies, he is an adjunct professor of biomedical engineering at the U of M and California Polytechnic University.

Mahandra Nath [ISyE M.S. ’65]
Founder, President and CEO, Nath Companies

Nath is honored as a dedicated civic leader who built one of Minnesota’s leading companies in the management of restaurants, hotels, and real estate. Nath came to the United States in 1964 from India with only $800 in his pocket. Today, Nath is CEO and President of Nath Companies, a leader in the management of restaurants, hotel, and real estate, including Burger King, Dennys, and Radisson. Nath credits his success to combining basic business concepts with innovation and vision. All company training focuses on quality, customer service, and attention to detail. He encourages employees’ entrepreneurial spirit and welcomes their input and ideas.

Yannis P. Tsividis [EE ’72]
Professor of Electrical Engineering, Columbia University

Tsividis is honored for his contributions to the field of silicon chips that mix analog and digital circuits. He and his students have completed extensive research in this field at the device, circuit, system, and computer simulation level.

In 1976, Tsividis designed and built the first fully integrated MOS operational amplifier and demonstrated its use in a coder-decoder for digital telephony. The results were widely adopted by the industry in the first massively produced mixed-signal MOS integrated circuits, which incorporate both analog and digital functions on the same silicon chip. He is a fellow of the Institute of Electrical and Electronics Engineers.

Save the date for Homecoming 2013

The College of Science and Engineering invites you to
CSE Homecoming Celebration
“Ski U Madness”
Friday, Sept. 27, 2013
University Recreation Center, North Gym
Watch your mailbox for more information.
Scholarships make all the difference for students

This academic year, about 1,200 science and engineering seniors graduated from the College of Science and Engineering—20 percent more than five years ago. They will go on to make our lives healthier, safer, more productive, and more enjoyable. They will solve difficult problems affecting our environment, energy security, national security, health, infrastructure and more. They are our hope for the future.

We must invest in our future by making sure talented young people can afford a world-class education in our college. The University is doing its part by freezing tuition costs for Minnesota undergraduates for the next two years. However, the cost to attend is still high, totaling more than $24,000 a year. Scholarships make a difference!

Recently, Karen Kaler, the University President’s wife, hosted an alumni event that highlighted the importance of scholarships. At this event, Samantha, a rising senior in mechanical engineering, spoke about the impact scholarships had made in her life.

Samantha grew up in Atwater, Minn., in a family of five children. Both of her parents had been laid off from their jobs during her last two years of high school. When it was time to apply to CSE, Samantha could not afford the $60 application fee, so she was not able to complete her on-line application. A University admissions counselor noticed her pending application and called to learn why it had not been submitted. Samantha explained the situation, and the admissions counselor waived the fee.

With the help of scholarships, Samantha, a national merit scholar, has been able to attend our college. An outstanding student and past president of Engineers Without Borders-USA University of Minnesota, she will head to San Diego this summer for an internship with Solar Turbines after she graduates from the College of Science and Engineering. This program will continue through December 2014 or until all incentive funds are committed, whichever is first. For each new endowment fund of $50,000 or greater, Fast Start will pay $24,000 a year. Scholarships make a difference!

You can support students like Samantha by establishing a scholarship. You can increase the impact of your scholarship by taking advantage of the new Fast Start 4 Impact program where you have a unique opportunity to:

- Create a new, named endowed scholarship supporting students.
- See the results of your giving right away.
- Continue your legacy with a scholarship or fellowship in your name.

For each new endowment fund of $50,000 or greater, Fast Start will pay four years of annual scholarship awards to students in an amount that is roughly equivalent to what the payout of the fully endowed fund will be at the end of the four-year period. It is designed to build a permanent revenue source for student support and provide funds when they are needed most—right now. Launched in September 2012, the program will continue through December 2014 or until all incentive funds are committed, whichever is first.

Help open doors for students by giving them the gift of an education. Your investment in their future is an investment that will benefit us all.

If you would like to learn more about Fast Start 4 Impact or any other giving opportunities, please contact Kim Dockter at dockter@umn.edu or 612-626-9385.
3M supports CSE as largest corporate donor

Many initiatives in the College of Science and Engineering would not be possible without the generous support of 3M, the college’s largest corporate contributor. Over the past several decades, 3M has given more than $19 million to the college. A few examples include:

Physics and Nanotechnology Building. Opening at the end of 2013, this new state-of-the-art facility will make a significant impact in expanding research and advancing the education of the next generation of high-tech workers in the state. 3M was an early innovator in nanotechnology with its dentistry products. The gift—$1 million and $500,000 in-kind product—helps to bring together nanotechnology research and expertise across the University into one location.

3M Chair in Experiential Learning. The holder of this chair will develop and lead experiential learning opportunities for CSE undergraduate students, which will enhance their undergraduate experience, improve retention rates, and better prepare them for entering the workforce upon graduation. The chair will also facilitate the CSE First-Year Experience course, also developed with 3M support.

3M Student Center. The 3M Foundation matched 3M employees and retirees’ gifts at a rate of 3:1 to support the Lind Hall renovation with nearly $400,000. The renovation created a convenient “one-stop shop” for CSE Student Services, including study and meeting space, conference rooms, student group offices, and CSE Computer Lab, used by over 200 students each day.

3M is the largest corporate donor in the Physics and Nanotechnology Building project that will open at the end of this year. The building will house 200 experimental physics faculty, post doctorate and graduate students, and visiting researchers.

Fast Start 4 Impact Scholarship Program. Over the years, 3M has provided support for a significant number of undergraduate scholarships. This year they took advantage of the Fast Start 4 Impact program and created another endowed scholarship with a $250,000 gift. Additionally, the company gives considerable amounts for supporting CSE student groups.

“We are grateful for the contributions we receive from 3M,” said Steven L. Crouch, Dean of the College of Science and Engineering. “With their support, we are able to provide a world-class education for students and a cutting-edge research environment for faculty working to solve the world’s most pressing problems.”

Support CSE students now and your gift will go further, faster.

Typically, an endowment fund starts small and grows over four years. Fast Start 4 Impact changes that. It awards U of M students right away.

You can see students benefiting shortly after you make a gift. After four years, your new endowment fund takes over. Even better, it continues to help students far into the future.

Learn more at giving.umn.edu

FastStart4Impact
Physics plans for Tate Lab renovation

For 86 years, the John T. Tate Laboratory of Physics (Tate Laboratory) has been home to the University of Minnesota’s School of Physics and Astronomy, which offers the core courses required to prepare students for a wide range of careers in engineering and science. Each year, nearly 4,500 students from dozens of majors pass through the halls of Tate Laboratory to receive instruction in physics and astronomy.

"Nationwide, we’re among the top 10 universities in the number of freshman students we instruct," said Ron Poling, professor and head of the School of Physics and Astronomy.

Given the number of students and faculty it supports, the current infrastructure of Tate Laboratory can no longer sustain today’s modern physics enterprise, which is vital to recruiting and retaining high quality faculty, and attracting support for cutting-edge research. The building is in need of a renovation, and one of seven investment projects on the University Board of Regents’ capital requests list.

Early beginnings of physics

The rich history of physics at the University of Minnesota dates back to 1889, when then University president Cyrus Northrop hired Frederick S. Jones, a young colleague from Yale, who became the first professor of physics and successfully taught for years. During Jones’ tenure, the first Physical Laboratory, now called Jones Hall, was completed in 1902. It was the first home of the physics department.

Changing needs and technological advances required a new facility be built 25 years later. In 1927, the front portion of Tate Laboratory was completed. Since then, the building has been expanded and remodeled nearly a half dozen times.

The most recent major renovation was construction of the space physics laboratories in the south wing, almost 50 years ago. In 2012, Tate Laboratory was designated a Historic Site for Physics by the American Physical Society.

Cutting-edge research and accomplishments

Past activities of physicists from the University’s School of Physics and Astronomy have been foundational to today’s technology-intensive world. Known worldwide, they include Alfred Nier, who built a high-precision mass spectrometer that first separated the fissile isotope of uranium (U-235); Edward Ney, who pioneered the use of high altitude balloons for scientific investigations; John Williams, a nuclear physicist who worked on the Manhattan Project; John Tate, who worked tirelessly to elevate Minnesota’s ranks in the field of physics, and countless more.

Six former faculty and alumni physicists have received the Nobel Prize, more than any other school or department at the University. They are pioneers in studying nuclear energy, particle theory, neutrinos, and many areas of physics fundamental to groundbreaking discoveries.

"Today’s experimentalists working in our labs in Tate do cutting-edge investigations of novel materials, study the physics of biological systems, and develop instrumentation used at dozens of the most advanced research facilities, some as near as north-
ern Minnesota’s Soudan Underground Laboratory and others as far as the South Pole or orbiting the earth. Theoretical physicists work to interpret the latest experimental data to achieve deeper understanding of matter and energy in all of their forms and of the structure and evolution of the Universe,” Poling said. “Students benefit by working side-by-side with these faculty on research projects.”

**Plans for the future**

With a building designed more than 80 years ago, physics at the University of Minnesota has been at a major disadvantage. “The basic mechanicals are a mess—bad roof, not energy efficient, and no central climate control. The building is inadequate for today’s research needs,” Poling said.

“Preliminary planning is currently underway,” Poling said. “Initial funding for the project will be sought by the University of Minnesota during the 2014 Minnesota Legislative session.”

When completed, the building will house the School of Physics and Astronomy and the Department of Earth Sciences, currently located in Pillsbury Hall.

“This will enable consolidation of programs in geology, geobiology, hydrogeology, geochemistry, and geophysics,” Poling said. “Earth sciences and physics are closely related fields, and there are longstanding connections between the two disciplines at the University.”

Plans call for a full gut of Tate Laboratory, which could start within a few years. To maintain the historical nature of the University’s main campus mall, the front of Tate Laboratory will be preserved.

Three designs are being considered. “One major component—the tank on the south side of the building that once housed a particle accelerator for nuclear physics research will be removed,” Poling said. “Currently, there’s no entrance on Church Street, and we would like it to connect to the mall. Many of our aspirations will depend on the final funding.”

In addition to updated offices, conference rooms, seminar and lecture spaces for faculty, students will benefit from high-tech spaces similar to the Science Teaching and Student Services Building, which opened in 2010. The concept is to provide new opportunities for learning and collaborating with peers, not just in classes and laboratories, but also in informal interactions and organized student group activities.

“Active learning and cooperative groups have been part of our teaching program for many years and have proven themselves with improved student achievement. Now we look forward to having facilities that will better support these innovations,” Poling said.

“We’re competing for the best and brightest students and retaining world-class faculty. This proposed renovation will increase our odds of that happening,” Poling added.

**BY SILVA YOUNG**
College of Science and Engineering Ph.D. student, Nessa Johnson, works in the Biomedical Functional Imaging and Neuroengineering Laboratory, directed by Biomedical Engineering Professor Bin He. She is using Transcranial Magnetic Stimulation (TMS) and EEG imaging to better understand motor and sensory recovery in stroke patients. Her research discoveries are leading to promising new treatments and cures for those who suffer from this devastating condition.

See more highlights at cse.umn.edu