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INVENTING TOMORROW

CURIOSITY DRIVES PROGRESS

Special Campaign Results Issue

INVENTING TOMORROW

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summer **2015**

INVENTING TOMORROW

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The College of Science and Engineering wraps up the comprehensive Campaign for Science and Engineering "Curiosity Drives Progress."

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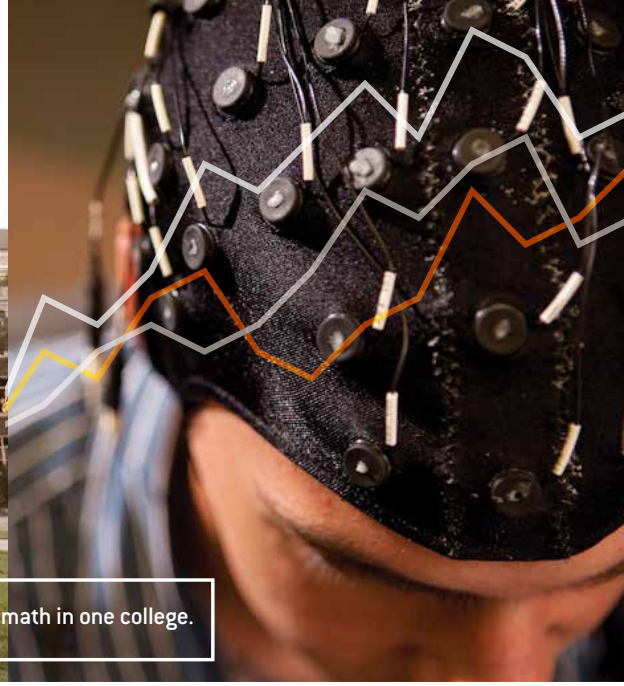
From top, left to right: The University of Minnesota Northrop Mall in early spring; Michael Tsapatsis, professor of chemical engineering and materials science; Taylor Center computer lab; Lind Hall's Collegiate Life reception area; scholarship recipient Sophia Kasahara; Gore Annex ribbon cutting ceremony.

PHOTOS BY RICHARD G. ANDERSON, PATRICK O'LEARY, JOSH KOHANEK, AND LKPB ENGINEERS, INC.

CSE is the only large public research university that combines engineering, science, and math in one college.



CURIOSITY DRIVES PROGRESS

I have served as Dean of the College of Science and Engineering (CSE) for the past 10 years. During that time, I have been proud of our accomplishments, the energy of our students, and the dedicated work of faculty. With the support and investment of our alumni, corporate partners, and friends, CSE has become a truly extraordinary place.

STEVEN L. CROUCH, DEAN

Many of you may have heard about the looming shortages of scientists and engineers in the United States. As an educational institution, I believe it is our obligation to help drive the economic engine of the future by producing more scientists and engineers. In 2009, I established an ambitious goal to increase the number of science and engineering graduates by 20 percent. To achieve this initiative, I felt we needed to increase the number of scholarships and fellowships in order to compete for the best and brightest students; establish endowments for new chairs and professorships to recruit outstanding faculty who would support the additional students; and invest in our learning environments by renovating outdated structures and constructing new state-of-the-art facilities.

In 2010, we launched the comprehensive Campaign for Science and Engineering "Curiosity Drives Progress" with a target goal of $150 million. Thanks to our generous supporters, I am happy to report that we not only have reached our fundraising goal, but have surpassed it by more than $26 million. And the best news—with enrollment now at about 5,200 undergraduates and with about 430 faculty members on staff—the number of bachelor's degree graduates has increased by more than 39 percent!

Today, I look at our college with renewed enthusiasm. It has been exciting to see the impressive student population and equally impressive faculty that make this college truly great. Freshmen are now entering the college with average ACT scores of more than 31, and the demand for admission has more than tripled with nearly 13,000 applications for 1,100 seats. Our faculty is more remarkable than ever, making breakthrough discoveries in many areas to improve everyday life, and winning prestigious national and international awards. It's a proud time to be an alumnus of the College of Science and Engineering!

I urge you to visit campus to see how your contributions have made a difference:

- If you attended the college's commencement ceremony in May, you may have seen Ben Ihde walk across the stage to receive his B.S. degree in Physics. With financial support from the Bentson Family and Edmond B. Franklin Scholarship Funds, Ben earned his degree in four years and graduated with a 3.8 GPA. He is just one of more than 1,300 new CSE alumni who will build careers using their science and engineering skills and knowledge to help solve the world's greatest challenges.
- Walk over to the Mechanical Engineering building where you will find Distinguished McKnight University Professor John Bischof in the Bioheat and Mass Transfer Laboratory. Bischof—holder of an

NEARLY 13,000

FRESHMEN APPLICATIONS FOR 1,100 SEATS IN 2015

31.1 Average ACT score of entering CSE freshmen in fall 2014, the highest ever for the college.

1,342 515 235

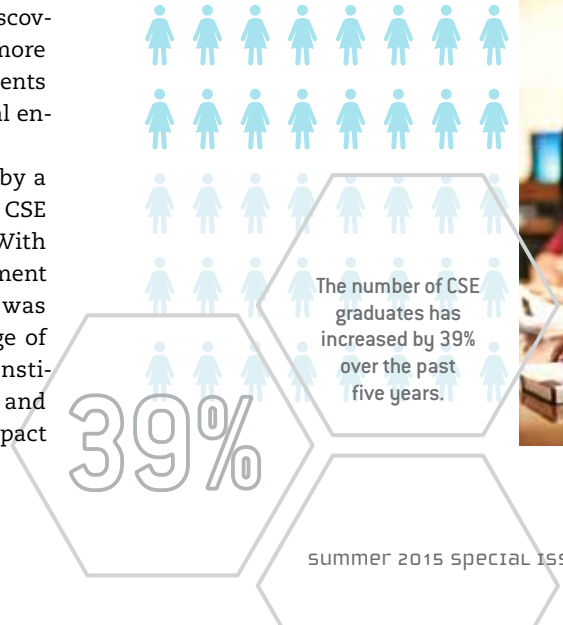
More than 1,342 bachelor's, 515 master's, and 235 doctoral degrees are awarded annually.

endowed chair in mechanical engineering funded by Carl and Janet Kuhrmeyer—and his research team are working in the area of nanomedicine to treat cancerous tumors using nanoparticle systems with heat or cold.

- Visit renovated Lind Hall, which is a nucleus of activity for CSE students that fosters community among our students and accommodates space for academic advising, the career center, student programs, student study, the Taylor Center/CSE computer lab, and even a café. More than 135 individuals, companies, and foundations provided $4 million toward the renovation of Lind Hall.
- Continue on to Amundson Hall and you will see the Gore Annex, a new 40,000-square-foot-expansion, made possible with gifts by Bob and Jane Gore, Dow Chemical Company, and Valspar Corporation. Beyond its impressive research facilities where solutions to energy and human health problems are being discovered, its new teaching laboratories will enable more high-achieving undergraduate and graduate students to benefit from one of the nation's best chemical engineering and materials science programs.

All of these examples and more were fostered by a comprehensive campaign committee of dedicated CSE alumni, led by Ron Christenson (ME '72) as chair. With the committee's insightful leadership and commitment to the college, they ensured that the campaign was a success and the University of Minnesota College of Science and Engineering will remain a first-class institution to educate future generations of scientists and engineers. Our students and faculty will feel the impact of your generosity for years to come. Thank you!

Nearly 29 percent of our incoming freshmen are women.



WE DID IT!

KIM DOCKTER
DIRECTOR OF EXTERNAL RELATIONS

When I walk around the University of Minnesota campus, I am reminded every day of what makes this place so great—the students and the faculty. Whether they are exploring space, finding cures for deadly diseases, searching at the nanoscale, expanding renewable energy sources, or increasing the power of information technology, CSE faculty and students are working on discoveries with real-world impact.

I am also proud to witness the generosity of our alumni, friends, and corporate partners. From supporting students and faculty, to providing funds for the new Physics and Nanotechnology Building and Gore Annex, and the renovation of Lind Hall, your generosity has been transformative. In these new and renovated facilities, CSE is producing the next generation of scientists and engineers, future graduates who will help to solve world challenges as well as fuel the nation's economy. Your gifts help to make it all possible.

Since the launch of the **Campaign for Science and Engineering "Curiosity Drives Progress"** in July 2009, we have worked tirelessly to achieve our goal of $150 million. The campaign officially ended June 30. At the time of this writing, I am proud and pleased to report that the total number of gifts and commitments are now at $176 million! I want to sincerely thank all of you who made this campaign successful. Your gifts, large or small, have supported the college in numerous ways.

OUR CAMPAIGN GOALS

$60 MILLION > STUDENTS
Support for scholarships, fellowships, and experiential learning programs.

$30 MILLION > BUILDINGS
Open new buildings and renovate outdated facilities for new learning environments.

$40 MILLION > FACULTY
Endow new chairs and professorships to attract and retain high-quality faculty.

$20 MILLION > OPPORTUNITIES
Take advantage of opportunities for bold new initiatives.

CAMPAIGN RESULTS >

$80.2M

STUDENT SUPPORT>
- > $37.6 million for undergraduate scholarships.
- > $33.2 million for graduate student fellowships.
- > $9.4 million for experiential learning projects, student leadership development, and Living Learning Communities.

$62M

FACULTY SUPPORT>
- > More than $34.2 million, including 16 new chairs and professorships.
- > Approximately $27.8 million for innovative research.

$22.6M

BUILDINGS > $22.6 million for state-of-the-art facilities.

BUILDINGS > More than $22.6 million for new or renovated buildings, and more lab space for students and faculty.

Here are a few examples:

• **More scholarships to deserving students.** Since the beginning of the campaign, the number of CSE students receiving collegiate scholarships has nearly doubled, and the average amount awarded has increased by nearly 42 percent! From a total of $790,084 awarded in 2008 to $2,360,388 this past year, the total amount of scholarships awarded has nearly tripled!

• **Enhanced student experience.** More than $9 million is supporting experiential learning projects such as the First-Year Experience, Solar Vehicle Project team, Tesla Works, and Engineers Without Borders, as well as student leadership programs.

• **State-of-the-art facilities.** CSE faculty can now teach, conduct research, and collaborate with faculty across the University in modern, leading-edge space thanks to gifts of more than $22.6 million for new or renovated facilities.

• **Endowed faculty support to attract and retain world-class faculty.** More than $34.2 million has provided funds for 16 new chairs and professorships and endowed faculty support.

Every gift made to CSE during the campaign timeframe, regardless of amount or how it was directed, was counted toward our campaign goal. On behalf of our students and faculty who will benefit from your generosity, I thank you.

Finally, I want to thank our campaign chair Ron Christenson and Dean Steven Crouch for their leadership of the campaign, and the many campaign volunteers who devoted considerable time and energy to reach our goal. With their guidance, we surpassed our goals, which enhances our ability to make a difference in creating the leaders of tomorrow.

TOTAL CAMPAIGN GOAL

$150 MILLION

TOTAL RAISED >

$176 MILLION

$10.8M

OPPORTUNITIES >

> $10.8 for strategic initiatives—unrestricted funds for emerging opportunities.

WHO GAVE >

ALUMNI	CORPORATIONS/ FOUNDATIONS	FRIENDS
$100M	$55M	$20M

FACTS AND FIGURES >

> Gifts ranged from $1 to $10 million—**every gift matters.**
> Deans Club membership increased by 40%—donations of $1,000 to $24,999 per year.
> $65 million in new will provisions and life income gifts—the majority will be added to the college's endowment upon maturity.
> The college's endowment grew by 67.2%.
> The average cost of raising $1 was less than 10 cents.

Curious Alumni

DRIVE SUCCESS

WRITTEN BY GREG BREINING

CSE alumni provide insights about curiosity and how it drove their success.

Ted Johnson (CSci '82), co-founder of Visio, a diagramming and graphics software company, says continual questioning is essential to science and engineering.

SHEILA ADDLEMAN

Curiosity is a curious thing.

To believe popular culture, we're a bit ambivalent about its value. Curiosity killed the cat, after all. And early 20th-century wit Dorothy Parker opined that "Four be the things I'd been better without: Love, curiosity, freckles, and doubt."

But Victorian writer and critic John Ruskin called curiosity "a gift, a capacity of pleasure in knowing." And teachers almost universally agree that curiosity motivates exploration and learning. The late Herbert A. Simon, Nobel laureate and professor of psychology at Carnegie Mellon University, wrote that "curiosity is the motor that interests children in science. It is also the principal motor that energizes and steers the education of professional scientists and the conduct of their subsequent scientific work."

But where does curiosity come from? Is it innate and fixed? Or can an ambitious student acquire and cultivate a curious nature? And more to the point of education, can schools and universities such as the University of Minnesota College of Science and Engineering instill and hone the quality of curiosity?

We asked four science and engineering alumni about the importance of curiosity. Is it something we can acquire and grow? Does it really drive progress?

There was plenty of uncertainty and disagreement about the nature of curiosity and where it comes from. But everyone acknowledged curiosity is indispensable and that it is key to another highly valued trait—creativity.

Ted Johnson—Design visionary

Ted Johnson's (CSci '82) computer career came about as a mixture of curiosity and luck—good and bad. "I often tell folks that if there's one single event that changed my life, it was jumping out of a window and breaking my ankle. That event ended one career and started another," Johnson said.

Johnson's career with computers started back in junior high. It was about 1970 when his math teacher got hold of the first computer Johnson had ever seen. He and a friend started learning programming.

"I was just curious about that," he said. "We just loved this. We'd go in at 7 a.m. before school and we'd program on that thing. By the time we were in ninth grade, we were going to the high school to use the better equipment they had."

"The funny thing is I did not think I'd do that as a career," Johnson said. Yet, he enrolled at the University of Minnesota to study architecture, going to school during the day and loading UPS trucks in the evening.

That's when he broke his ankle. "In the process of playing a joke on my then-girlfriend (now wife) and her roommate, I jumped out of the second-story window of their dorm room," he said. His ankle needed surgery and Johnson wore a foot-to-groin cast for two months. That ended the UPS job.

But he found a job at the *Minneapolis StarTribune* working only on weekends so he could continue going to school. He worked with Paul Brainerd, a former editor of the *Minnesota Daily* who was employed with the *StarTribune*, and Atex, a company that installed and developed software to edit, design, compose, and paginate newspapers.

"It was cool to me," said Johnson. "Here you have a system used by journalists to put out a newspaper—computers used as tools by professionals. It was when the newsroom started liking computers because they resulted in better journalism. The stuff was easier to write, easier to revise. You could change things more easily. The product out the other end is better just because of the tool you can use to write it."

He liked the job so much he quit school to work for the *StarTribune* full-time before returning to the University, switching his major to computer science, and finishing his degree. He went on to work for Atex, Brainerd's wildly successful start-up company Aldus (later purchased by Adobe).

In 1990, he co-founded Visio and its diagramming and vector graphics application for business. The company was sold to Microsoft in 2000 for $1.3 billion. Since then, Johnson has served in top-level management positions at Microsoft. In 2002, he and his wife Linda gave the University $1.5 million to develop new digital design tools for architects, engineers, and designers. Today, Johnson is a managing member at Programmers in Jeans Building Apps in Bellevue, Wash.

Johnson attributes his successful career to his broken ankle, but it was his natural curiosity that hooked him on computers. Nearly all kids start out being curious. "Who doesn't ask, 'Why's the sky blue? Where do babies come from?'" he said. "Maybe the question should be, 'What shuts curiosity down?' Maybe it's how young kids get answers to those early questions, whether they stay curious or not."

Johnson says that kind of questioning is essential to science and engineering. "Sometimes curiosity just helps you get aimed at the problem you're going to solve," he said. "Engineering in particular is about problem solving."

But the curiosity and the creativity it provokes isn't an abstract or self-centered exercise. In the real world, problem-solving is usually "customer driven," he said. "A colleague of mine said whether you're starting a company or adding a product to a company you have, find a problem that customers have—one that you can solve, and a problem that customers are willing to pay to have solved. Progress comes when something is made available to people who need it."

Kim Chaffin—Passion for polymers

Kim Chaffin (ChemE Ph.D. '99) thinks of curiosity as a skill to be developed. But she sees a big difference between idle and productive curiosity. "I think just to be curious for curiosity's sake doesn't drive progress," Chaffin said.

Chaffin is a chemical engineer and distinguished scientist—her actual title—at Medtronic and as a member of the company's honored Bakken Society. Her specialty is polymers, which she has studied in all kinds of applications—from oilfields to automobiles, and as components of medical devices inside the human body.

Chaffin acknowledges she entered engineering without much curiosity—about the profession itself or the kinds of problems engineers struggle to solve. Instead, she was just doing the dutiful thing—studying hard to get good grades in hopes of getting a job.

"I found myself with an engineering scholarship and then trying to figure out what kind of an engineer I wanted to be. I was from a small town without any former exposure to what an engineer even did. I have to say I wasn't very curious only because I did not have enough exposure to the field to know it even existed," Chaffin said.

After completing a bachelor's in chemical engineering at the University of Michigan, she worked on her masters (at Michigan) while helping to design the heating and cooling system of the 1994 Mustang. At Ford, she first felt asked to exercise her curiosity in creative problem solving. The problem was a robot that dispensed glue to seal the headlight lenses and reflectors together. As the factory warmed during the day, the flow rate of adhesive changed and had to be adjusted by hand. Trouble was, the adhesive had to cure for 20 minutes before the lamps could be leak-tested. Meanwhile, 500 headlights were assembled—500 headlights that would have to be thrown away if the adhesive hadn't been adjusted correctly.

Chaffin was on the team to solve the problem. The most obvious answer—keep the robot warm. "But how do you put a temperature control around a single robot in this gigantic facility?" Instead, they found a way to quick-cure the adhesive in 15 seconds before testing—during which time only four headlamps might be wasted. "It wasn't so much that we discovered a new way to cure the adhesive," said Chaffin. "It was about thinking carefully and differently enough that we could solve the problem from a different perspective."

Taking an educational leave from Ford, Chaffin worked on her Ph.D. at the University of Minnesota, which she felt had the best chemical engineering department in the country. She wrote her thesis on the thermodynamics of block polymers (research sponsored by Exxon because of its importance to the oil industry). Chaffin planned to return to Ford, but her professional life took a turn when she gave a talk on polymers at Medtronic.

RICHARD G. ANDERSON

Kim Chaffin (ChemE Ph.D. '99), Medtronic chemical engineer and distinguished scientist, confesses she entered engineering without much curiosity.

Medtronic offered her a research job in its expanding research area. "It was intriguing to me to get in on the ground floor and be an integral part of how to grow research in polymers at Medtronic," Chaffin said.

At Medtronic, Chaffin has published many papers on materials that must perform without fail inside the body. "I love what I do and my creativity has grown with time. It's a skill you have to hone and work on. I can point to many mentors I've had through the years who have taught me how to ask questions better, how to make better connections."

To be productive, Chaffin says, curiosity must be harnessed by some disciplined process.

"I think curiosity is the desire to study a problem deeply, with the goal to learn, not just for yourself, but for the benefit of society. That means making connections that no one has made before, and that's your contribution to moving that knowledge front forward," she said.

Perhaps the best example—where she found her curiosity tested in college—was in defining, researching, and writing her Ph.D. thesis in the field of polymer thermodynamics. "The goal of the thesis is to expand the engineering knowledge frontier. And if you don't expand that knowledge frontier in some unique way, you don't have a thesis that will get you a Ph.D. You have to pick a problem that's going to motivate you, engage your curiosity over a very long period of time, and be relevant to the scientific community. It is also a time when one can learn from their fellow academics how rewarding well-directed curiosity that eventually drives discovery can be. That's why I would argue the thesis is where the importance of curiosity is taught," she said.

Grant Erickson—Making lives better

Grant Erickson (EE '96, M.S. '98) straddles the fence of the nature-nurture debate: Yes, curiosity is something you're born with, but it can also be honed. However, he has no doubt that curiosity drives discoveries in science and creative solutions in engineering. "I really believe," he said, "engineering is the art of science."

No surprise, Erickson is an engineer. He worked two years for Apple on several generations of the iPod and the first iteration of the iPhone. "That was absolutely a fantastic experience to be able to work on those two transformational products," he said.

After Apple, he founded Nuovations, his engineering design consulting firm to handle side projects. He is also principal engineer of the startup Nest Labs, founded in Palo Alto, Calif., by two other Apple engineers. One device Erickson helped create is the self-programming Nest Learning Thermostat.

Nest specializes in bringing an Apple level of design savvy to "unloved products," such as thermostats. "We reinvented a device that hasn't really been touched or updated materially for the last 20 to 30 years," Erickson said. The Nest thermostat uses machine learning to set the temperature according to the homeowner's past preferences day-to-day and throughout the day.

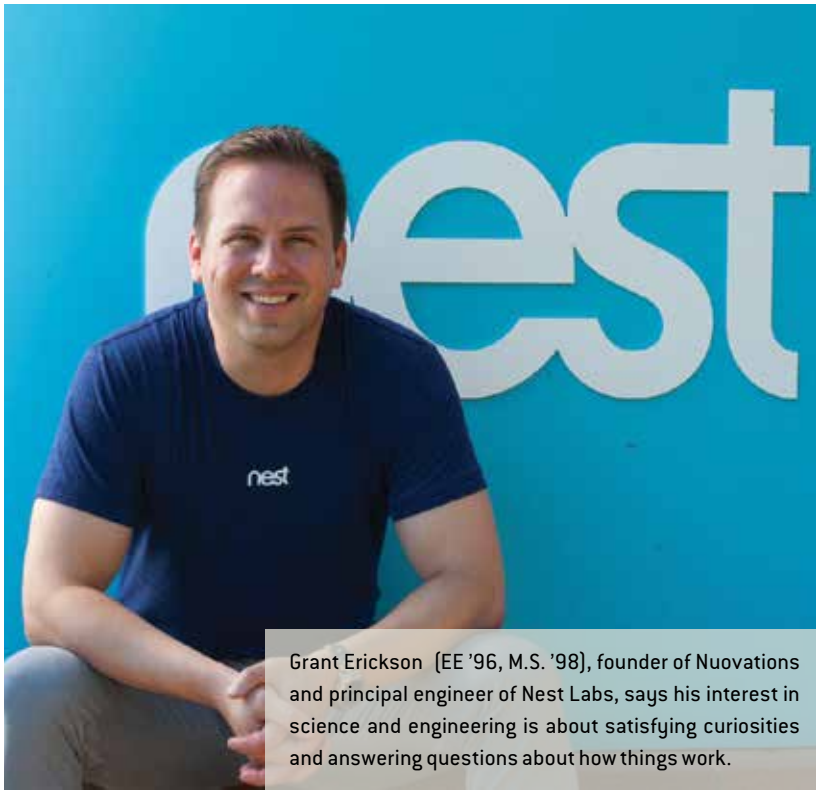
Erickson was one of those kids whose curiosity about the world around him became apparent early on, evidenced by disassembled toys and spare parts. "Much to my parents' chagrin, one of the most frequent things they found with me is that, while I might play with a new toy for a while, invariably there was a trip to the toolbox to get a screwdriver out, take it apart, and figure out what made it work."

That curiosity led him into engineering at the University. "I certainly think my interest in science and engineering has been about satisfying curiosities and answering deeper questions about how things work and why things are," he said.

Erickson clearly came to the University loaded with curiosity. "I thought there was a fantastic balance of in-classroom rhetorical learning mixed with in-lab experimentation, exploration-type of exercises. The in-class rhetorical learning offers you the framework to understand what it is you're exploring and what questions you're going to be asking," he said.

But the best opportunity to exercise his curiosity came in the laboratory, particularly in self-directed research with faculty to look at a particular question and say, "Okay, how do we solve this problem? Or how do we learn more about this?"

He had a passion for audio and music, so he thought he might study signal processing and communications. He soon discovered he really liked the application of computing—not so much in a traditional sense where computers are front and center in our lives, but looking at what is known as the embedded systems world, when computers become transparent and in the background.



Grant Erickson (EE '96, M.S. '98), founder of Nuovations and principal engineer of Nest Labs, says his interest in science and engineering is about satisfying curiosities and answering questions about how things work.

KELVIN YUE

"My other passion for engineering is creating things, things that could help make people's lives better, help people do things in better, more efficient ways than they had before," Erickson said.

"Problem solving requires not only curiosity, but also its close twin, creativity," Erickson said. He was struck by the fact that both at Apple and at Nest the engineering teams included a high proportion of musicians and left-handers. (Erickson, too, is left-handed.) While neither trait is proof of being creative, Erickson thought it a remarkable correlation. He certainly thinks of engineering as a creative endeavor.

"Science, of course, is all about the theory and what's possible and here's how things work," said Erickson. "Engineering is very much taking that science and applying it to solve problems. For engineers, science is really the palette, the toolbox, the field of herbs and spices to chose from. The best engineers I've known are absolutely creative thinkers and creative problem solvers asking, 'How do I create a solution to a particular problem using limited resources?'"

Mark Kroll—Creative problem solver

When it comes to asking how something can be improved, Mark Kroll (Math '76, ME M.S. '83, Ph.D. '87) can hardly help himself. He recalls a few years ago standing in an airport security line. The table where passengers spread out their luggage was placed awkwardly so that the line snaked back on itself and traffic jammed to a halt.

Kroll figured he knew a better location.

"I thought to be helpful I'd just mention it to a supervisor there," he said. "I was hoping for a good citizen award. Boy, I didn't get it. I was told in no uncertain terms I was to get with the program and get in line."

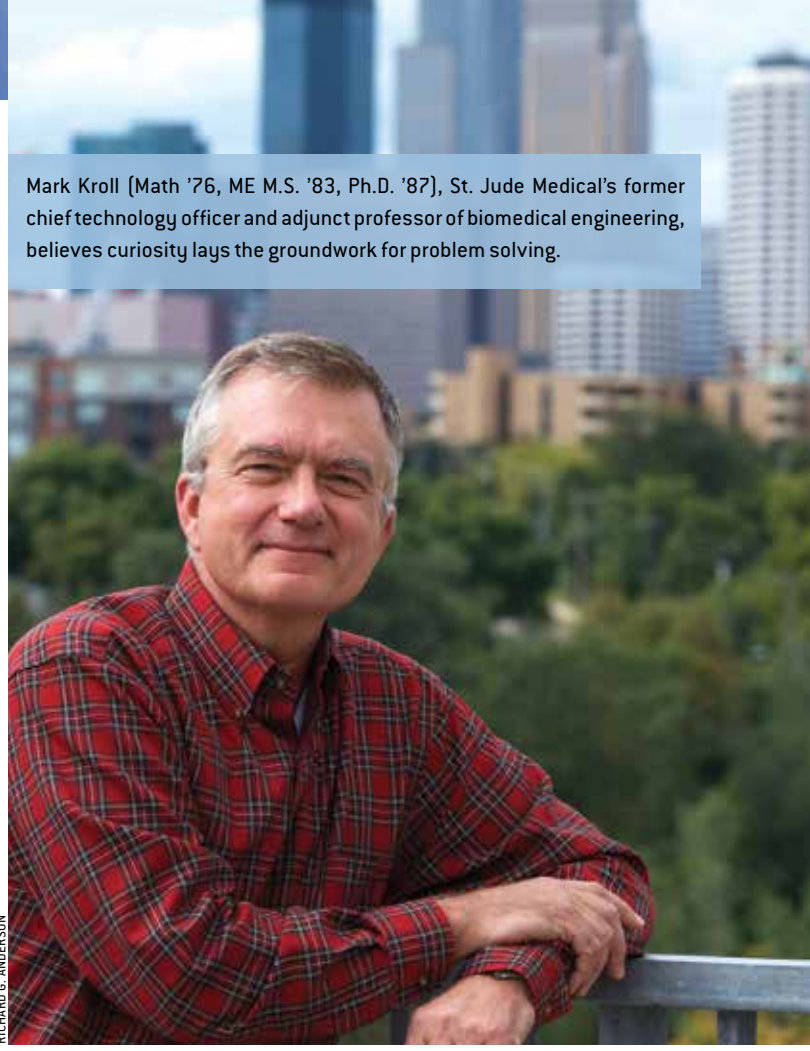
He realized that sometimes curiosity is troublesome. A prime example is researching on the Internet. "Curiosity, ADD, and creativity have a lot of overlap. So you start going on the Internet, and you can spend your life there and not get anything done," he said.

It is an ironic precaution from someone who has spent his professional life exercising his curiosity to the max. A former chief technology officer of St. Jude Medical and an adjunct professor for the University's Department of Biomedical Engineering, Kroll holds more than 350 U.S. patents, including more patents on medical devices than anyone one else alive. He has been associated with several start-up companies, either as inventor, technical advisor, or investor—from high-speed Internet for airlines, to medical devices, to a phone system for calling your dog.

For Kroll, curiosity is innate but is also honed through discipline and habit.

The first step is to read a lot. "I need to build up this pantry full of technology knowledge. You fill that pantry by studying a certain kind of technology in college, and by lots of reading. A lot of that reading is driven by curiosity," he said.

To solve problems you need to be exposed to problems. At St. Jude, he was bombarded with problems—technical problems, manufacturing problems, marketing problems. It helped that he understood the context of problems and the relevant technology. "You start running through a list in your head—kind of like playing Bingo," Kroll said. For example, if he just heard about a new material, he wondered how it might apply to a product such as a defibrillator. "Some of it is not even that clever," he said. "It's just a matter of doing it as your job."



Mark Kroll (Math '76, ME M.S. '83, Ph.D. '87), St. Jude Medical's former chief technology officer and adjunct professor of biomedical engineering, believes curiosity lays the groundwork for problem solving.

RICHARD G. ANDERSON

Curiosity not only lays the groundwork for problem solving; it almost compels it. As a frequent presenter, Kroll is often asked questions that leave him with that "deer-in-the-headlights" look because he hadn't thought of that problem before.

"When I get on the plane, that's when the curiosity takes over," he said. He wonders why the problem exists and what he needs to know to understand it. He jumps on the Internet to research. "I can learn so much about that problem, and that's driven by my curiosity," he said.

Kroll says children develop curiosity in an environment that rewards it. His own kids grew up with a dad who developed patents. "They'd have a wild idea and they'd bring it to me and sometimes we would go and get a patent on it. I think that people can actually be encouraged to keep their eyes open. I've always said that the average person has got at least one million-dollar invention in their head," he said.

From his perspective—27 years after receiving his Ph.D.—Kroll reassures engineering students that their curiosity lays the groundwork for a satisfying life. "Your curiosity and technical education will come together to make such a difference for millions of people," he said.

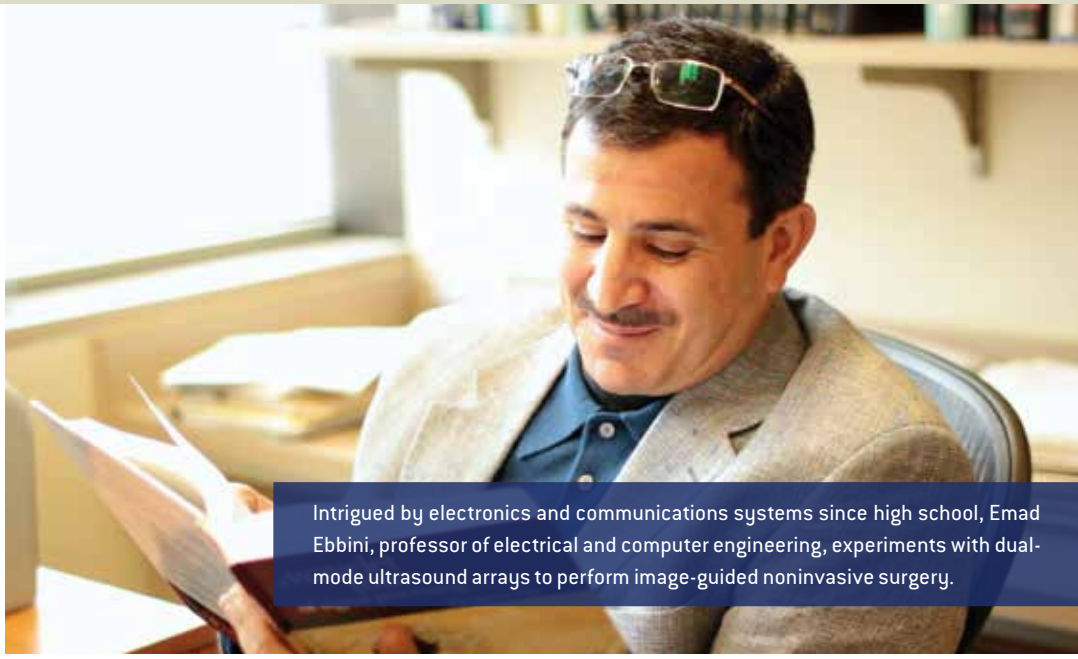
Defining moments

OF CURIOSITY

College of Science and Engineering faculty share their defining moments of curiosity that changed their careers.

WRITTEN BY EVE DANIELS

PHOTOS AND VIDEOS BY EVE DANIELS



Intrigued by electronics and communications systems since high school, Emad Ebbini, professor of electrical and computer engineering, experiments with dual-mode ultrasound arrays to perform image-guided noninvasive surgery.

Walt Disney once said, "We keep moving forward, opening new doors and doing new things because we're curious, and curiosity keeps leading us down new paths."

There are hundreds of quotes from esteemed scientists about curiosity, so why use one? Well, in this case, it works perfectly.

Pioneers like Disney are wired much like the researchers featured in this story. They're all driven by an insatiable sense of wonder. And they all solve problems with a balance of science and art.

Some say a particular person or event led them to their current field. Others believe they got here by accident, luck, or a little of both. Regardless of the reason, solving one problem has never been enough. One question inevitably raises another, deeper question.

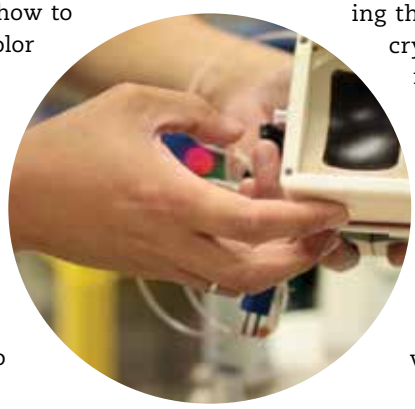
Here, we explore the nature of curiosity through the lens of four scientists, who discuss the ideas and questions that keep leading them down new paths.

An array of possibilities

Emad Ebbini, a professor of electrical and computer engineering, has been intrigued by electronics and communications systems since high school.

During the late 1970s, the TV in Ebbini's living room needed constant color adjustment, and he learned how to make these adjustments by dabbling with the color control circuitry. He fell in love with the field.

"I was able to tell that the colors are adjusted based on my measurements without looking at the TV screen," Ebbini said. "I wanted to learn more about the theory and the design principles for these systems."



As a college undergraduate, Ebbini was firmly focused on a career in telecommunications engineering. That is, until his dad passed away in 1985. "The doctors did one surgery to remove the tumor on his kidney," Ebbini said. "Six months later, the cancer came back and there was nothing they could do."

Shortly after his father's passing, Ebbini got an offer that felt a lot like fate. The University of Illinois at Urbana-Champaign was hiring a graduate student research assistant to help in developing phased array systems for thermotherapy, wherein body tissue is exposed to high temperatures to kill cancer cells.

"I thought if this could help patients like my dad, then I would like to be part of it," Ebbini said, whose doctoral thesis was the first to introduce the concept of optimal use of phased arrays in thermotherapy.

By the mid-1990s, Ebbini and his wife were expecting their first daughter, and a visit to the clinic crystalized the vision that has guided his research efforts ever since. "During the ultrasound, we were looking at the profile of my daughter's face, and I thought: Why don't we do guided imaging and therapy with the same device?"

That's when the idea of a dual-mode ultrasound array first captured his imagination. The only problem was that the enabling technologies for this concept were not in place to make it a reality.

Ebbini joined the University of Minnesota College of Science and Engineering as a professor in 1998. Over the next few years, Ebbini and his students worked on experiments to demonstrate the feasibility of his concept. His laboratory became the first to demonstrate the use of dual-mode ultrasound arrays in performing image-guided noninvasive surgery in excised tissue samples.

Millions of people undergo surgery every day and countless lives are improved in the process. But for some patients, conventional surgery may not be an option (for example, some late-stage liver cancers). Other options such as radiation and chemotherapy have their own risks and limitations.

Ebbini intends to change all that with the dual-mode ultrasound array. The noninvasive device, which has been compared to a lightsaber or a magic wand, involves no blood, no drugs, and no ionizing radiation. It can also be used to improve the efficacy of drugs and reduce the side effects of chemotherapy.

"The dual-mode ultrasound array approach is uniquely suited to maximize the safety and efficacy of noninvasive surgery," Ebbini said. As a result, patients can get treatment and be back in action within a matter of days.

Similar in look and feel to the ultrasound systems used during his wife's pregnancy and yet today, the system is essentially a "one-stop shop" for everything from pre-treatment imaging, to monitoring and control during treatment, to damage assessment after treatment.

The array is expected to be ready for human use within the next year, first for surgeries related to arteriosclerosis, and eventually for many other diseases. Needless to say, it's a game-changer with infinite possibilities.

"When we first started this research decades ago, I was confident that the real-time signal processing would be available some day," Ebbini said. "We had a vision and we were crazy enough to believe it would work."

Visit **z.umn.edu/ebbini** to view a one-minute video about Emad Ebbini's research.

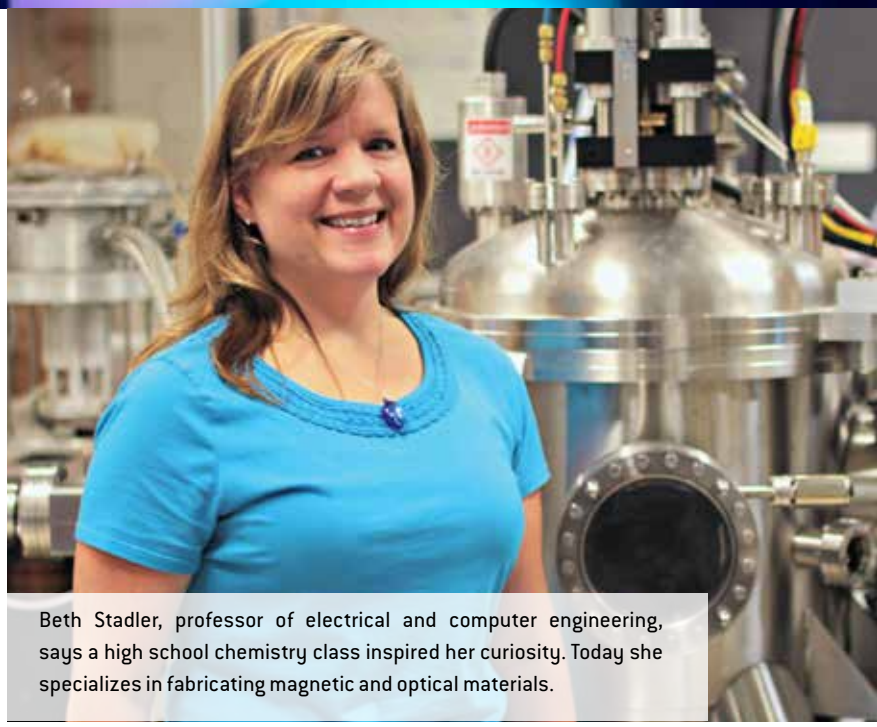
Magnetic behavior

One of Beth Stadler's most vivid memories happened in high school chemistry class. When her teacher put metals into a flame, it emitted a spectrum of bright reds, greens, and many other hues.

"I asked him, 'Why would metals that look the same give you such different colors?'" Stadler recalls. "My teacher said, 'You don't know enough for me to answer that right now.'"

At the time, Stadler was annoyed by this response, but it also inspired her to investigate further. "I took his advice and looked for those answers at increasing levels of complexity. In a way, I'm still looking deeper today."

Growing up in the small town of Chardon, Ohio, Stadler was a curious child with a penchant for invention. Case in point: her fourth grade marketing contest. The boys competed against the girls in creating the best poster to advertise a new gadget.



Beth Stadler, professor of electrical and computer engineering, says a high school chemistry class inspired her curiosity. Today she specializes in fabricating magnetic and optical materials.

The girls won the contest that year, in large part because Stadler developed the gadget rather than just promoting it. "It was a toy that flipped when you pushed a button. I figured it was easy enough to make. Why not try it?" she said.

Now, as a professor in the Department of Electrical and Computer Engineering, Stadler continues to innovate on a daily basis. Her group specializes in fabricating magnetic and optical materials for novel devices, with one focus being magnetic barcode nanowires.

Imagine a four-inch length of one human hair reduced by a million times. That's about the size of a barcode nanowire. Although extremely small, these wires have big potential in revolutionizing hard drives, memory, and even cancer therapy.

"The code is magnetic, so you can read it like a hard drive or spin it by placing a magnet under your flash drive, beaker or FitBit," Stadler explains. "We envision using these nanowires to kill cancer cells, multiplex and automate disease diagnostics, harness energy, or even produce a flash drive in a Band-Aid."

In collaboration with University of Minnesota experts in cell biology, cryotherapy, and other disciplines, Stadler and her research partners have already functionalized the magnetic nanowires to detect and separate certain cells. Her group currently conducts this research in vitro, but she believes the real-world applications are right around the corner.

Along with scientific curiosity, Stadler is energized by her faith. An openly devoted Christian, she is as open to questions about her beliefs as about her research.

"A lot of people think that science and faith can't go together, but I don't see the two conflicting," she said. "It's amazing how complicated everything is, in our bodies, in the universe. I think it's all out there for us to dig in and figure out."

Visit **z.umn.edu/stadler** to view a one-minute video about Beth Stadler's research.

Sun signs

In his high school senior yearbook, Eray Aydil's classmates voted him "most likely to be a professor." As an undergraduate, he double majored in chemical engineering and materials science. Today, he's a professor in the University of Minnesota's Department of Chemical Engineering and Materials Science and holder of the Ronald L. and Janet A. Christenson Chair in Renewable Energy.

Seems like Aydil had a plan and made it happen, doesn't it? Not according to him.

"I always loved finding things out, but I didn't wake up one day and decide to be a professor or a scientist," he said. "It was really just a series of accidents."

He started his research career working on integrated circuits, but as serendipity would have it, one field led to another. In the early 2000s, Aydil and one of his graduate students at the University of Santa Barbara were getting some exciting results with dye-sensitized solar cells.

Aydil was hooked. "I started writing proposals and getting funding, so my entire research shifted from silicon and integrated circuit manufacturing to photovoltaics and solar cell research."

In less than an hour, the sun provides enough energy to power our world for an entire year. In recent years, solar has seen the fastest growth as a source of renewable electricity. Accidental or otherwise, Aydil's move toward solar research was a smart one with infinite potential.

"If you look at the global installations of photovoltaic solar cells alone, it has been doubling every two and a half years for the past three or four decades," he said.

Yet, according to recent figures from the Institute for Energy Research, solar energy provides less than 1 percent of the total energy consumed in the U.S. and the world. In order for that number to increase, we must move closer to grid parity, or the point at which solar can generate electricity for the same cost or cheaper than coal or natural gas, Aydil said.

Aydil is optimistic, with good reason. States like California and Arizona have already approached the tipping point in terms of economic incentives to transition to solar. And researchers are responding to these growing demands with new, lower-cost materials.

"The one that I'm most excited about now is copper zinc tin sulfide, which we refer to as CZTS," Aydil said. Unlike copper indium gallium diselenide (CIGS) solar cells, which are expensive to make due to the scarcity of indium, all of the elements in CZTS cells are abundant and nontoxic.

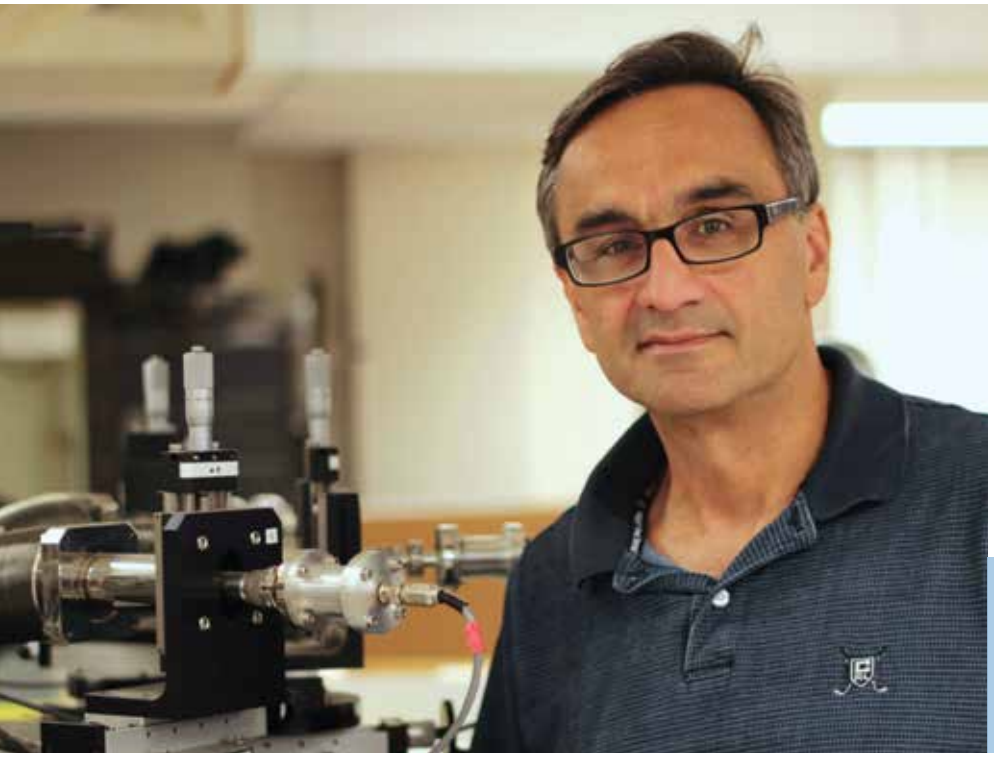
Right now, Aydil and his students are testing the properties of these solar cells in the lab, figuring out ways to address problems such as cracks, and producing thin films on a large scale in the lab. The goal is to develop a manufacturing process that could lead to a viable startup.

While the University of Minnesota is on the forefront of CZTS research, there are a few competitors, including IBM. But Aydil says that's all part of discovery—the fact is that "everyone builds on someone else's idea. That is how science works; we build a wall one brick at a time."

"There's always someone who's asking the same or a related question as you are," Aydil said. "But once there's a spark of an idea, it spreads like wildfire."

The key to spreading good ideas and turning them into reality? Aydil believes his students are the best vehicle.

"You have a higher probability of making an impact through your students than yourself. I know how much time research takes, how many challenges there are. But these students don't know any better. When they walk through that door, they're ready to change the world."



Visit **z.umn.edu/aydil** to view a one-minute video about Eray Aydil's research.

Eray Aydil, professor of chemical engineering and materials science, started his career working on integrated circuits. Today he focuses on photovoltaics and solar cells.

Marc Hillmyer, professor of chemisty, had initially started out to become a medical doctor. As director of the University's Center for Sustainable Polymers, he is working on ways to make better plastics.

Building a better plastic

Marc Hillmyer's office is filled with eye-catching conversation pieces, from the bright green paint on his walls to the molecular models on his shelves. But his favorite piece is easy to overlook. It's a small sampling of plastics, which he holds and stretches while explaining his current research.

"See, they're just as stiff or flexible as the plastics that come from petroleum," Hillmyer said, "but these all come from sugar."

It's true, you can't tell the difference. While some bioplastics are no match for their petrochemical counterparts, Hillmyer's samples are extremely durable. Yet, thanks to their highly oxygenated content, they will naturally break down over time.

There's no denying that plastics have become a huge problem in our environment—in our bodies, landfills, oceans, and beyond. They're also central to our daily lives, from our cars and computers to our clothing. The fact is, they aren't going anywhere anytime soon.

"Some people respond to the word 'plastic' as if it's evil," Hillmyer said. "But actually they're modern materials that, if used judiciously and sourced intelligently, can be a big benefit to society."

This next generation of plastics not only needs to be attractive to industry and consumers from a performance and cost standpoint. The plastics also need to be nontoxic, biodegradable, and recycled, composted, or incinerated by environmentally sound methods.

It's a complex problem to solve, but the University of Minnesota's Center for Sustainable Polymers is up for the challenge. As director of the center, Hillmyer has already watched several ideas and projects generated in the laboratory catch the attention and interest of industry, and these successes and technology transfers push him forward.

"I love basic research, but I'm also passionate about how what we do can translate to technological realities."

Thanks to a recent $20 million grant from the National Science Foundation, the center has a significant edge in translating new materials to real-world uses. "Our goal with the new funding cycle is to really go for it," Hillmyer said. "Let's figure out how to revolutionize the polymer industry."

Part of the Phase II Center for Chemical Innovation program, the grant represents one of the most significant investments in the history of the NSF's Division of Chemistry. With the award, the Center for Sustainable Polymers will continue to bring together top researchers from the University of Minnesota, Cornell University, and the University of California, Berkeley, along with more than 30 companies from across the nation.

"We're going to push on the side of high-risk, high-reward research, while staying grounded in the economic realities of the industry," Hillmyer said.

As an undergraduate in college, Hillmyer had initially planned on becoming a medical doctor. But after learning about general chemistry from an enthusiastic professor, he was inspired to dig deeper into the field.

Today, as a chemistry professor at the university and holder of the McKnight Presidential Endowed Chair, Hillmyer is paying it forward. "I'm enthusiastic about polymer science, and I try to communicate that enthusiasm to my students. It's more than just facts and figures. It's something that impacts our lives and our future."

Visit **z.umn.edu/hillmyer** to view a one-minute video about Marc Hillmyer's research

Curious Minds

LOOK TO THE FUTURE

SCHOLARSHIPS ENABLE CSE STUDENTS TO DREAM BIG

WRITTEN BY RICHARD BRODERICK
PHOTOS BY RICHARD G. ANDERSON

Anthony Vecchi
Scholarships Awarded

- Bonestroo, Rosene, Anderlik & Associate Scholarship & Faculty Award
- Clifton T. Barker Scholarship
- Iron Range Merit Scholarship
- Frank Louk Scholarship
- U Promise Scholarship

Since its inception, the University of Minnesota College of Science and Engineering has acted like a magnet drawing the best and the brightest to its classrooms and research labs from across Minnesota, the United States, and the world at large.

Proof of this continuing power of attraction can be seen throughout the college and elsewhere. It can be seen in the cutting-edge teaching and research carried out by faculty. We see it in the academic and research accomplishments of CSE's students. We also see it in the contributions to society made by CSE alumni, many of whom, in turn, demonstrate their esteem for CSE by making generous donations and establishing scholarships that enable future generations of student-seekers to follow their own dreams.

Scholarship assistance, which includes academic merit scholarships, named scholarships, and University scholarships, positively impacts the lives and pocketbooks of our CSE students. Your contributions help to ensure the outstanding caliber of our students and helps each CSE student to dream big.

To give you a better idea of the kind of high-achieving students who are today pursuing those dreams, we asked four of them to share their stories with us. What first attracted them to STEM fields and CSE? How have scholarships helped them achieve their goals? What are their plans for the future? And, above all, what challenging scientific or engineering problem do they dream of tackling—and solving—during the course of their careers?

Anthony Vecchi: The great outdoors

"I went to high school in Duluth where I was on the swim team, and I'm an avid cyclist," said Anthony Vecchi, a 2015 CSE civil engineering graduate. "Being outside and active is very important to me."

But how exactly to transfer that passion into a career choice was not immediately apparent to Vecchi when he first enrolled at the University of Minnesota as an undecided major. But then, things changed.

"I basically did a little soul searching about a career that

would be fulfilling to me," he recalls. "I thought about growing up beside Lake Superior and how beautiful and pristine it is. And I knew that it is that way because someone made it happen."

Inspired, he looked over the University's course catalog and came upon civil engineering, a path that seemed right for him. Still, he wanted to do a little research first.

"I was aggressive about it," he said. "I wanted to make sure it would be a good fit." So he emailed the president of the University's student chapter of the American Society of Civil Engineers. "I thought it would be best to get a student's take on the department here at CSE," he said. He was not only invited to attend the next meeting but to join the organization's board of directors.

"I was just expecting to be invited to a presentation but instead I become a freshman representative, and—before I knew it—a board officer," marvels Vecchi, who subsequently went on to become the chapter's board president.

Just after settling on a major, he spent the summer following his freshman year working with John Gulliver, a professor of civil engineering, on a research project on stormwater infiltration in manmade highway ditches, technically known as swales. During that time he also discovered—and fell in love with—the University's St. Anthony Falls Laboratory.

"It's pretty cool to be in an environment like that, surrounded by people who know more than you working on projects funded by NASA, the DOE, and the Army Corps of Engineers," he enthuses. "The project I was working on is pretty humble compared to some of the work there, but it's been great to go there every day in the summer and be around some really inspiring people."

Vecchi, who's received a Bonestroo, Rosene, Anderlik & Associate Scholarship among others, has continued working on the swale project over the past three years. As the scope and depth of the research he conducts has grown, so has his certainty that he made the right choice three years ago.

"When I started the project, I had no idea what a swale was or how to calculate anything or even why it was good for them to infiltrate water," he said. "To go from that to where I am now is very rewarding and a validation that no matter where you start you can be amazed by where you end up.

"It's been a real confidence booster."

Megan Rubbelke
Scholarships Awarded

- Lijenstople-Wejnarth Scholarship
- Jay and Rose Philips Family Scholarship
- Richard P. and Judy C. Hokanson Scholarship
- Presidential Scholarship
- U Promise Scholarship

Megan Rubbelke: Building community

When Megan Rubbelke, who received her degree in mathematics this past spring with a specialization in education, graduated from high school in the small northern Minnesota town of Aitkin, she received her diploma in the company of exactly 86 fellow seniors. Small wonder that, when it came time to choose a college, one of the criteria she sought was community.

"I drew up a spreadsheet of things that are important to me," she recalls. "I wanted to stay in Minnesota and discovered there's a strong sense of community in CSE, along with a reputation for rigor and academic achievement.

"These were the largest factors that brought me to the University of Minnesota," she said.

With the help of a number of scholarships, including the

Michael Braun
Scholarships Awarded

- Academic Excellence Scholarship
- Kaler Family Scholarship
- Clifford I. and Nancy C. Anderson Scholarship
- U Promise Scholarship

Richard P. and Judy C. Hokanson Scholarship, Rubbelke began her quest, throwing herself into a wide array of on- and off-campus activities, including a stint as president of CSE's Women in Math, whose University chapter she helped initiate. But it wasn't until she left the country briefly that she found what she was looking for.

"I really found the kind of community I was seeking in Scotland," said Rubbelke, who spent the Spring 2013 semester studying at the University of St. Andrews in Scotland. "I returned with renewed determination and helped put together the Women in Math group. This helped me connect and collaborate with other student groups."

From those connections, in turn, Rubbelke was invited to be a student representative in the CSE Women's Working Group. This group is not confined to students but is open to CSE faculty and staff; among its members are a University scholarship coordinator and an academic advisor.

The group is a networking organization designed to expand the boundaries of "community." To date it has staged non-programmed events, such as book discussions and meet-and-greets, but recently, held its first programmed event at a popular restaurant near the East Bank campus of the University.

"The idea is to start meeting people outside your own department," Rubbelke explains. "That can be hard to do, especially for students in the upper divisions." This year the group is planning events that will bring professional women to campus to give presentations about their careers and careers paths, among other pending ideas.

In addition to CSE, Rubbelke is also enrolled in a program in the College of Education that prepares undergraduates to pursue graduate degrees in education, which is what she plans to do after completing her degree in mathematics. She has already been accepted in the M.A. program in education at the University.

"What I would really like to do when I complete my education is to create a program for high school students in northern Minnesota that focuses on academic, social, physical, and mental well being by incorporating international experiences before college," Rubbelke said. "I want to create networks of students with a greater cultural awareness who are able to use their experiences throughout school and into their professional lives to be successful."

Michael Braun: Complex applications

There were many factors that attracted Michael Braun to major in materials science and engineering in the College of Science and Engineering.

The University is only 90 minutes north of his hometown of Rochester, Minn., and offers the added advantage of being located close to downtown Minneapolis, with an array of academic, social, and cultural opportunities. Plus, CSE is highly ranked in the field he's pursuing.

Then, too, and perhaps most important, were the multiple scholarships he has received, including the Clifford I. and Nancy C. Anderson Scholarship, which nearly covered his tuition. "This funding meant that the University was not only highly regarded but also financially attainable for me," Braun said.

In naming his most rewarding experience so far in CSE, Braun cites his work with the Leighton Research Group, headed by Christopher Leighton, a professor in the Department of Chemical Engineering and Materials Science who is also the department's Director of Undergraduate Studies. At the suggestion of his then physics professor, Braun began volunteering at the Leighton lab in his freshman year. He then was hired in the fall as an undergraduate research assistant.

"The research I'm doing is in material systems on a complex oxide that has interesting electrical and magnetic properties,"

he explains. “I’m looking at the physics that causes the features we are observing, such as a phenomenon known as persistent photoconductivity.”

Persistent photoconductivity is a property that could prove useful for any number of applications, for example in optical switching devices. Complex oxides also are being investigated for their potential use in a variety of other applications.

In the Leighton research lab, Braun plays several roles in these investigations. In addition to working with the research team, he has, on his own, set up an electromagnet and a closed cycle refrigerator system that can reach temperatures as low as 8 Kelvin (-265 °C) without the use of liquid helium.

He also works on his own sub-project investigating different properties of the complex oxide $La_{1-x}Sr_xCoO_3$, in his case the complex oxide is a film as thin as 3 to 30 nm. Thin films in general have additional applications that Braun is particularly interested in, such as coatings for LED displays or on camera lenses.

A May 2015 graduate, Braun intends to go to graduate school to obtain a Ph.D. in materials science. Due to the wide array of potential fields to work in, he says it’s difficult to pin down exactly what he plans to do after finishing his doctorate.

“I think this is a field with a lot of potential,” he says. “Take, for example, cracks in roads and bridges like the one that led to the collapse of the 35W bridge in Minneapolis [in 2007]. That could have been prevented with a material that healed itself when cracks first appeared.

“This could save money and lives by making roads and bridges much safer by alerting us to the fact that things are going wrong before, say, the sudden collapse of a bridge,” he said.

Amanda Dahl: Curiosity is the word

“Curiosity” is a word that pops up often in Amanda Dahl’s life.

It was curiosity that led her to apply to the College of Science and Engineering where the Woodbury, Minn., native, now in her senior year, is majoring in biomedical engineering. It was curiosity about the options available to her within the school that has led her to tour labs throughout CSE and beyond at the University. Curiosity also led her to Bali last spring as part of a cross-cultural leadership study abroad program.

“I chose engineering because I am a very curious person and I like to learn about systems and how they work,” said Dahl, whose campaign to satisfy her curiosity is being underwritten by nearly a half dozen scholarships. “CSE is well-known for its programs, of course, including biomedical engineering.”

Beyond that, she decided on the University among other schools she was considering in part because of location. The University is not just close to home for her, it is, even more important, in her words, “a center of innovation for biomedical heart therapies, which is what I am interested in.”

It also helps that the University is located in the same town as biomedical device industry leaders such as pacemaker-pioneer Medtronic, Boston Scientific, and St. Jude Medical. “This gives me a lot of opportunity to get to know these companies, which in turn means I have more opportunity to get an internship at one of them. And someday, perhaps even a career fulfilling my dream of developing medical devices to help people who suffer from scoliosis or the effects of back injuries,” she said. In particular, her time spent in Bali inspired a dream to make medical devices more affordable, and hence accessible, to patients throughout the world, including developing countries.

“That’s what I’m really passionate about,” she said.

Closer to home, one of the most rewarding experiences Dahl has had at CSE was her time as a CSE Ambassador, a peer mentoring group that pairs incoming freshmen in the college with seniors, where she served last year as the group’s coordinator. She herself was a freshman mentee in her first year in the college and is now, in her final year as an undergraduate, serving as a mentor. “I can’t speak highly enough of this program,” she said.

From that experience and similar experiences in the college, she has fashioned a bit of sound advice for any student thinking of enrolling in CSE.

“Create genuine relationships with those around you,” she said. “Take advantage of getting to know your professors, the CSE career and advising counselors, and the CSE administration. They are all here to enhance your experience and will take an interest in what you do. Remember: such relationships are the currency of power.”

Amanda Dahl
Scholarships Awarded

- Iron Range Merit Scholarship
- William E. Brooke Scholarship
- Project Lead the Way Scholarship
- Global Leadership Scholarship
- Freshman Admissions Study Abroad Scholarship

Leadership Gala celebrates curiosity

The College of Science and Engineering celebrated its comprehensive Campaign for Science and Engineering with a Leadership Gala held at McNamara Alumni Center last fall.

Themed "Curiosity Drives Progress," the event, which celebrated curiosity and all those who help to fuel it, brought together more than 450 alumni and friends of the college who have supported CSE with their gifts of $1,000 or more.

Highlights of the gala included an Innovation Showcase featuring a sample of groundbreaking teaching and research in the college, dinner, and program with singers, dancers, and award presentations by CSE Dean Steven L. Crouch and University Regent Patricia Simmons.

Richard M. Kruger (ME '81), CEO and President of Imperial Oil, Ltd., and CSE Dean's Advisory Board member, served as emcee of the event. "Today's science and engineering challenges demand creative and educated minds—innovators who ask the critical questions and work tirelessly to discover the answers," Kruger said. "CSE's faculty and students are pushing forward the frontiers of discovery and redefining what's possible every day."

INNOVATION SHOWCASE

COLLEGE OF SCIENCE AND ENGINEERING FACULTY AND STUDENTS ARE LEADING AND COLLABORATING THE WAY TO DISCOVERIES THAT HAVE REAL WORLD IMPLICATIONS EVERY DAY.

ENERGY

When will solar cells become a substantial source of electricity?

Eray Aydil, professor of chemical engineering and materials science, and his researchers are developing inexpensive methods for making solar cells from abundant and nontoxic materials.

Can wind energy power the nation with renewable electricity?

Fotis Sotiropoulos, professor of civil, environmental, and geo- engineering, and his research team are developing advanced simulation tools and utilizing massively parallel supercomputers to optimize wind farm performance and reduce the cost of wind energy.

ENVIRONMENT

Can sophisticated plastics come from simple sugars?

Marc Hillmyer, professor of chemistry, and members of the University's Center for Sustainable Polymers are designing, discovering, and developing new ways to convert biomass into the plastics of tomorrow.



THE NUMBER OF DEAN'S CLUB MEMBERS (DONATIONS OF $1,000 TO $24,999) INCREASED NEARLY

40%

FROM 2009 TO 2015

David Odde, professor of biomedical engineering, and Black Label Movement, a collective of dance artists, team up to combine dance and science.

Chris Cramer, Associate Dean for Academic Affairs, sings a rendition of "Imagine."

Rich Kruger (ME '81), CEO and President of Imperial Oil, Ltd., served as emcee.

From left to right, Mark Board (GeoE '75, M.S. '77, Ph.D. '94), Misha Burich (EE M.S. '75, Ph.D. '78) and Patrick Foley (CivE '71) received the Outstanding Achievement Award; Rebecca Bergman received the Award of Distinction; University Regent Patricia Simmons; Ronald (ME '72) and Janet Christenson, and Jane and Robert Gore (ChemE Ph.D. '63) received the University Regents Award; and CSE Dean Steven Crouch.

Can bacteria clean water while creating energy?

Paige Novak, professor of civil engineering, and her collaborators are placing encapsulated bacteria in wastewater to simultaneously generate clean water and valuable energy in the form of hydrogen.

HUMAN HEALTH

Can we map the dynamics of your brain?

Bin He, professor of biomedical engineering, and his research team are developing techniques for mapping brain dynamics and allowing disabled patients to control devices by using only their minds.

Can nanotechnology help treat cancer?

Beth Stadler, professor of electrical and computer engineering, and her research team are developing nanowires for uses ranging from creating smaller, faster hard drives to treating cancer.

ROBOTICS

Can robots and sensors improve human well-being?

Nikolaos Papanikolopoulos, professor of computer science and engineering, and his research team are investigating the building of robots and sensors for search and rescue, environmental monitoring, assessing mental health, and diagnosing cancer.

Can robots help early diagnosis of autism spectrum disorders?

Maria Gini, professor of computer science and engineering, and her research team are developing robotics and computer vision technology to facilitate early identification of autism spectrum disorders in young children.

ECONOMIC DEVELOPMENT

How does U of M technology improve water quality and grow jobs?

Alumnus Arthur Schwidder and his company are commercializing technology from the University's St. Anthony Falls Lab to remove sediment from storm sewers before it enters our lakes and streams.

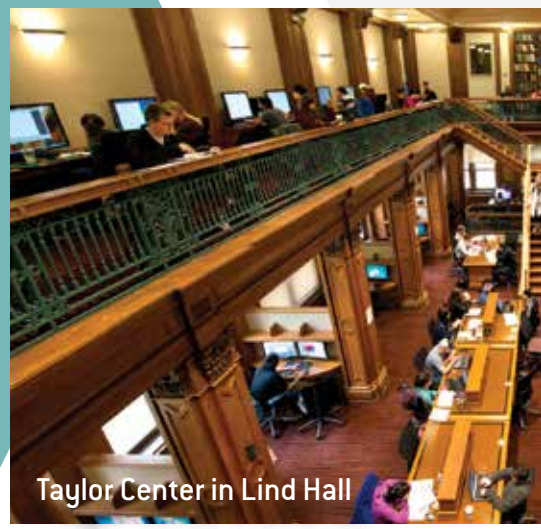
WORKFORCE DEVELOPMENT

How can hands-on learning prepare students for the workforce?

Frank Kelso, professor of mechanical engineering, and his colleagues are incorporating an experiential, hands-on design and build component into the freshmen curriculum.

The Campaign for Science and Engineering: Donors

Philanthropy has played a major role in helping the University of Minnesota College of Science and Engineering fulfill its mission. Donors have established scholarships for promising students, endowed chairs and professorships for faculty, and provided funds for innovative research and learning environments. Meet a few of the people who, through their gifts and commitment, are helping the college produce talented scientists and engineers capable of tackling humanity's more serious challenges.



Taylor Center in Lind Hall

Donor: Robert Gore

Robert Gore (ChemE Ph.D. '63) was looking for a way to produce a less expensive plumber's tape in his experiments with polytetrafluoroethylene (PTFE). At the time, his company, W. L. Gore and Associates, manufactured and sold PTFE cables. Not only did his experimentation lead to a cheaper plumber's tape, but to a breathable, waterproof fabric called GORE-TEX® used by outdoor enthusiasts worldwide.

With their gift of $10 million, Gore and his wife, Jane, have helped to create an atmosphere that encourages similar experimentation with Amundson Hall's new Gore Annex, which opened late 2014. The 40,000-square-foot addition includes lab space, collaborative environments, and state-of-the-art materials testing equipment for both graduate and undergraduate students.

Raised in a family of entrepreneurs and scientists, Gore said his graduate work at the University of Minnesota stretched his skills to the next level. "Giving back to the program that contributed so much to my own career is high on my list of good and important things to do," said Gore.

Leaving a legacy

George (ME '34) and Edna Taylor made the first of many gifts to the College of Science and Engineering more than 40 years ago. They have left a legacy of generosity that has helped the college to address challenges, solve problems, and promote a thriving intellectual community.

Taylor, who graduated with a degree in mechanical engineering in 1934 and died in 1978, had a successful career with the Woodward Governor Company, founded by his grandfather. After his death, Mrs. Taylor faithfully carried out her husband's wishes to give back to the institution that gave him an opportunity to succeed until her death in 2012.

Over the years, the Taylors have given more than $12 million to support CSE students, faculty, and facilities.

Donor: Chad Furey

Chad Furey (EE '12) landed his dream job as an electrical engineer with Tesla Motors in Palo Alto, Calif., after he graduated. He credits his participation on the Solar Vehicle Project (SVP) team.

Furey confesses his grades were "OK but not great" as a CSE student. Nevertheless, due to his experience with the SVP team, his phone interview with Tesla lasted just five minutes. He was hired right away.

On the SVP team, Furey developed a permanent magnet motor for the car, which increased efficiency by 10 percent with minimal cost. Today, he brings that expertise to his motor design projects at Tesla, where he specializes in power density and efficiency.

"I believe my success has been driven by my experience with the Solar Vehicle Project and the classes I took in CSE. I received a very nice financial package to help me through college. Now, I feel it's my responsibility to help my successors," said Furey. "I spent many hours raising money for the Solar Vehicle Project, and we put our hearts into making those pennies go far."

"With my gift, I know the SVP team can make my money stretch 10 times further than I can, and I know that the people who come out of that program understand how things work—and how to work with people," he added.

Some examples of their gifts include:

The Mr. and Mrs. George W. Taylor Foundation Scholarships, which remain the largest financial award package for exceptional CSE students.

Support of the Gifted Mathematics Fund, which helps to underwrite the University of Minnesota Talented Youth Mathematics Program.

The George W. Taylor Distinguished Teaching Award, Research Award, Service Award, and Career Development Award, which enable CSE to recognize exceptional faculty.

The Taylor Undergraduate Academic Center that provides a place for CSE student tutoring, advising, and study space.

The Taylor's philanthropy led the way in the Lind Hall renovation, which opened in 2012. Today, Lind Hall is a dynamic home base for CSE undergraduate students.

Donor: Robert F. Hartmann

Robert Hartmann (EE '65) began his career as a design engineer for a leading computer chip manufacturer. He eventually pioneered the world's first programmable logic circuit device, providing the technology industry with fast, efficient, high-density applications. He also co-founded Altera Corporation, in San Jose, Calif., a manufacturer of reprogrammable local devices.

Hartmann acknowledges that his college education served him better than he could have ever imagined. He gives back to the college that helped to launch his success by establishing the Robert F. Hartmann Scholarship Fund and Robert F. Hartmann Chair in Electrical and Computer Engineering.

"My degree in electrical engineering was life changing, and I wanted to provide an opportunity for others to experience the value of a college education," he said. "Putting money into education is one of the few places where it can have a long-term, perpetual effect. This is the best way I can contribute to society and where it has the most impact."

3M supports future scientists and engineers

As the College of Science and Engineering's largest corporate supporter, 3M has given more than $21 million over the past several decades to prepare future leaders in science, technology, engineering, and math. Funds have been used to build the new Physics and Nanotechnology Building, which opened in December 2013; the Lind Hall renovation—used by more than 200 CSE students each day; numerous undergraduate scholarships; the 3M Chair in Experiential Learning, a faculty position that directly supports the CSE undergraduate experience, and much more.

"A global company like 3M recruits top scientific talent around the world, yet we are fortunate to have an outstanding college in our backyard," said Ashish Khandpur, head of Research and Development at 3M. "For decades, University of Minnesota graduates have strengthened 3M with innovations ranging from dental and medical products, to signature 3M products like sandpaper and tape."

Khandpur, who studied chemical engineering at the University of Minnesota, continued, "I know from my own experience that University of Minnesota graduates are prepared well to apply science to real problems to make the world a better place, which is exactly what 3M is all about. We are proud to support an institution that has played an important role in our success."

DONOR HONOR ROLL

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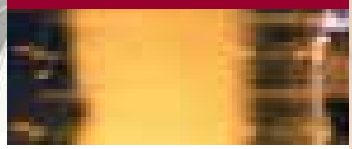
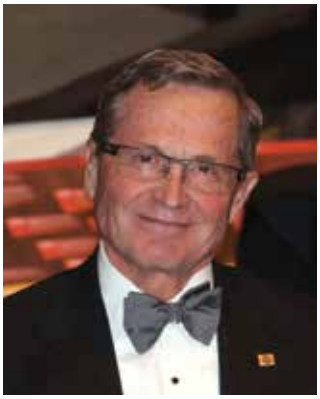
Companies founded by CSE graduates have generated more than $90 billion in revenues.



CSE graduates have founded more than 4,100 companies.

4,100

A REMARKABLE ENDEAVOR!



RONALD L. CHRISTENSON (ME '72)
CAMPAIGN CHAIR

On behalf of the College of Science and Engineering, I want to thank you for the extraordinary success of the Campaign for Science and Engineering "Curiosity Drives Progress." What a truly remarkable endeavor this has been. I am so impressed with the results and your outstanding support for our mission to educate the next generation of scientists and engineers.

As a proud alumnus of the College of Science and Engineering, I have the utmost respect for today's students and faculty who are carrying forward the college's tradition of excellence.

There is so much I can point to when I'm asked, "Why Minnesota?" I answer them with passion. Every day in the college, innovative solutions to world problems are being discovered—protecting the environment, pioneering forms of sustainable energy, new cures and technologies for healthier lives, and groundbreaking powers of information technology.

When you think about all the major problems that the world faces and all the possible solutions, the future lies in educating our students. They are bright and ambitious, and they also want to tackle problems facing the human condition as a scientist or engineer. Today's challenges demand creative, educated minds—innovators who will ask the critical questions and work to uncover the answers.

As we celebrate the success of this campaign, I want to thank my fellow campaign committee members and faculty campaign committee members. Their leadership, guidance, and vision have built upon the college's tradition of success that was established more than 75 years ago when the college was founded. In addition to their time, commitment, and involvement with the campaign, collectively as a whole the campaign committee members contributed more than $16 million in personal gifts to the campaign! Thank you!

Your contributions and support have helped to make the College of Science and Engineering even greater. Yet, this is only the beginning. There is more work to be done. With your continued support, we will produce even more outstanding graduates whose fresh ideas, curiosity, and drive will help us make progress—and lead us to a better world. For in the end, education is the key to making a difference in this world. Thank you, one and all.

Campaign Committee Members

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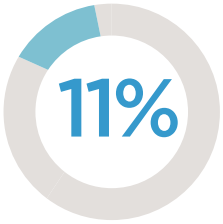
On average, U of M students are graduating with $34,000 of debt.

CSE students spend 32 weeks in the classroom, plus 20 weeks building their resume in the real world, which equals OPPORTUNITY.

17 Fortune 500 companies are based in the Twin Cities.

25 CSE academic programs perennially rank among the top 25 nationwide.



Only 11 percent of the world's undergraduate science and engineering degrees are awarded by U.S. educational institutions.

CSE graduates are sought out by companies worldwide.

Engaged alumni help to enhance and strengthen CSE

Four years as a student, the rest of your life as an alumni.

2014 CSE Mentor Program

2014 American Solar Challenge finish line

Not only can you support the College of Science and Engineering with your donation, there are many additional opportunities for lifelong involvement—with your classmates, your friends, and your alma mater. Be a part of the worldwide network of more than 65,000 CSE alumni.

Come back to campus for alumni events

Every year, the College of Science and Engineering hosts a number of events both in Minnesota and nationwide where you can network with other alumni, learn about the ways science and engineering are impacting society, or connect with old friends. Some include:

- Homecoming
- CSE Public Lectures
- 50-Year Reunion and Golden Medallion Society
- Regional alumni events

Get involved

Enrich the CSE student experience by getting involved and supporting student programs and events with your time and expertise. Some areas include:

- CSE Mentor Program
- Be a student group guest speaker
- Judge a senior design project
- Host an event for prospective students
- Help with mock interviews

Learn more

Contact Alumni Relations to learn more about how you can get involved: Ann Terry at **asterry@umn.edu** or **612-626-1802**.

American Chemical Society National Historic Chemical Landmark dedication ceremony

Stay connected

Join us on social media, and make sure your email and mailing addresses are current. Visit cse.umn.edu/update.

Join us on the College of Science and Engineering Facebook page at: facebook.com/umn.cse. Also learn about recent news and connect with other alumni on Twitter at: @UMNCSE; YouTube at: youtube.com/umncse; LinkedIn at: cse.umn.edu/linkedin; and see photos on Flicker at: cse.umn.edu/flickr.

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CSE student light show 2014

50-Year Reunion Class of 1965

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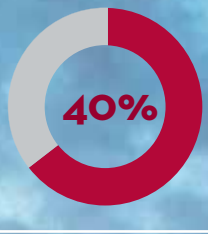
2,000 years
on a single-processor computer is equivalent to what supercomputer Mira—with 800,000 processors—can run in **1 day**

14 BILLION
gallons of ethanol were produced in the United States in 2014



of corn grown in the United States is used to produce ethanol

USING ONE OF THE WORLD'S LARGEST SUPERCOMPUTERS, WE'RE MAKING DISCOVERIES THAT COULD BE HUGE FOR THE FUEL INDUSTRIES.

19 gallons of gasoline and **12 gallons** of diesel fuel are produced from one barrel of crude oil

Producing fuel economically is a big challenge. The key is finding the best materials to convert chemical compounds. Researchers in the University of Minnesota's Department of Chemisty and the Department of Chemical Engineering and Materials Science are using a supercomputer at Argonne National Laboratory to discover materials that could improve the production of ethanol and petroleum products. It's one more way the future is being Made in Minnesota.

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