REPLACEMENT PARTS
Researchers restore structure and function to damaged tissues and organs >>

ALSO INSIDE:
Students gain work experience with co-ops >>

Alumni are making our world cyber secure >>
Farewell

As I end my time as dean, I increasingly reflect on the good fortune I have had to provide leadership for faculty, staff, and students in the College of Science and Engineering. I also reflect on the special opportunities I have had to meet so many alumni and friends who share a passion for our academic programs and generously support them. The past 11 years seem to have gone by in a rush, but I am truly grateful for the many good things that have happened during that time.

From my office in Walter Library, I can look out across Northrop Mall and see some of the construction work now in progress on the renovation of John T. Tate Hall. I am then reminded of the numerous other building projects that have been undertaken in the college while I have been dean, including: construction of the Physics and Nanotechnology Building and the Gore Annex to Amundson Hall and renovations of Kolthoff Hall, the St. Anthony Falls Laboratory, and portions of Lind Hall and Akerman Hall.

Much more building work is still needed—and some is currently underway—but I believe that the groundwork has been laid to ensure successful careers for all of the outstanding faculty and students we continue to attract to the college. I’m bullish on the College of Science and Engineering!

It is important to note that the end of my time as dean also means the beginning of another person’s good fortune—Samuel B. Mukasa will officially begin his appointment as dean of the College of Science and Engineering in September. Dean-designate Mukasa’s profile is on the next page. I will take this opportunity to wish him good luck in keeping the college moving on an upward trajectory.

Many of you will know that I grew up in Sleepy Eye, Minn., and that I have three degrees from the University of Minnesota: B.S. (1966), M.S. (1967), and Ph.D. (1970), all in Mineral Engineering. I never set out to be a dean, or for that matter a professor, but things have a way of evolving and I would not trade my time at the University of Minnesota for anything.

I want to thank everyone who has helped me over the years, going back to that day in late September 1961 when I started out as a freshman in the Institute of Technology. Without so much help from so many people things would certainly have turned out differently for me, but I doubt that they could have turned out any better.

In sincere gratitude and with best wishes for the future.

Steven L. Crouch

FROM THE DEAN

STEVEN L. CROUCH

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We’re online!

The College of Science and Engineering’s Inventing Tomorrow publication is available electronically.
To view an interactive online version of the current Inventing Tomorrow or to see past issues, visit our archives at: cse.umn.edu/inventingtonight.
NEW CSE DEAN NAMED

Samuel B. Mukasa has been named dean of the University of Minnesota College of Science and Engineering, effective Aug. 31, 2016.

As chief executive officer and chief academic officer, Mukasa will provide strategic and intellectual leadership and administrative oversight for the college and will work to advance its research, teaching, and service.

Mukasa previously served as the dean of the College of Engineering and Physical Sciences and as a professor of geochemistry at the University of New Hampshire. Prior to his role at the University of New Hampshire, he spent 21 years on the faculty at the University of Michigan, where he was chair of the Department of Geological Sciences from 2007 to 2010.

Mukasa completed his undergraduate degree at the University of New Hampshire in geology, received a master’s in geology from Ohio State University, and holds a postdoctoral degree in geochemistry from the University of California-Santa Barbara.

He completed a postdoctoral fellowship at Lamont-Doherty Earth Observatory of Columbia University in New York. He also received a D.Sc. honorary degree from Nkumba University, Entebbe, Uganda, in 2008.

He has served as president of the Geochemical Society and in leadership positions for programs at the National Science Foundation and National Academy of Sciences focused on polar climate issues, among many other scientific and professional leadership roles. He is a Fellow of the American Association for the Advancement of Science and the Geological Society of America.
New simulations may help make quieter jet engines
The roaring noise of a jet engine may be quieter, thanks to a group of University of Minnesota researchers who recently carried out a study investigating noise generation connected with jets. Their findings, published in *Physics of Fluids*, explain why jets are so loud and suggest new approaches for bringing down the volume. To learn more, visit [z.umn.edu/jetnoise](http://z.umn.edu/jetnoise).

Inexpensive tool will diagnose infections faster
Chemistry professor Valerie Pierre is developing an inexpensive, easy-to-use diagnostic tool that can diagnose bacterial infections faster. With a grant from the University’s Clinical and Translational Science Institute (CTSI), Pierre is beginning work on a dipstick-like tool that can test for an infection and instantly deliver results. To learn more, visit [z.umn.edu/diagnostictool](http://z.umn.edu/diagnostictool).

Gut bacteria may predict infection risk following chemo
A study, led by researchers at the University of Minnesota and the Nantes University Hospital in France, show that gut bacteria may predict the risk of life-threatening blood infection after high-dose chemotherapy. The research was recently published in *Genome Medicine*. To learn more, visit [z.umn.edu/chemo](http://z.umn.edu/chemo).

Scientists create sustainable way to turn agricultural waste into green products
University researchers have found a new way to turn agricultural waste, like corn stover and orange peels, into a variety of useful products ranging from spandex to chicken feed. The scientists say the breakthrough is more efficient and cost-effective than current methods. The study was recently published in *Nature Chemical Biology*. To learn more, visit [z.umn.edu/greenproducts](http://z.umn.edu/greenproducts).

National initiative will weave technology into smart fabrics
University researchers are part of a $317 million public-private partnership, called Advanced Functional Fibers of America, to develop “smart” fabrics. The goal is to develop fibers that have the functionality of semiconductor devices or fabrics that can see, hear, sense, communicate, store and convert energy, regulate temperature, or monitor health. To learn more, visit [z.umn.edu/fabrics](http://z.umn.edu/fabrics).
Scientists record heat moving through materials at speed of sound
Using a state-of-the-art ultrafast electron microscope, University researchers have captured on video how heat energy moves through materials at the speed of sound. The research, recently published in *Nature Communications*, could help to develop better, more efficient materials for electronics and alternative energy. To learn more, visit z.umn.edu/heatvideo

Spatial computing helps to understand dimensionality of real world
Computer Science and Engineering Professor Shashi Shekhar discusses how computers have come to understand the peculiar dimensionality of our real world in a video about spatial computing. To learn more, visit z.umn.edu/dimension

U researchers working to improve taste of Mpls. water
Civil, Environmental, and Geo-Engineering Professor Ray Hozalski and his research team were sought out by the Minneapolis Water Treatment and Distributions Services to improve the smell and taste of the city’s drinking water. The team is testing several treatment options for the water that comes from the Mississippi River. To learn more, visit z.umn.edu/mplswater

Small blue galaxy could shed new light on Big Bang
A faint blue galaxy about 30 million light-years from Earth and located in the constellation Leo Minor could shed new light on conditions at the birth of the universe. The team, including University of Minnesota researchers and astronomers and others, recently found a galaxy nicknamed Leoncino that contains the lowest level of heavy chemical elements ever observed in a gravitationally bound system of stars. To learn more, visit z.umn.edu/littleleon

Scientists detect gravitational waves
An international team of scientists, including U of M researchers, have observed ripples in the fabric of spacetime called gravitational waves, arriving at the earth from a cataclysmic event in the distant universe. The discovery confirms a major prediction of Albert Einstein’s 1915 general theory of relativity and opens an unprecedented new window into the cosmos. To learn more, visit z.umn.edu/gravitational

Lithium battery material found to harm key soil microorganism
The growing use of the new nanoscale materials used in rechargeable batteries that power portable electronics and electric and hybrid vehicles may have untold environmental consequences. The study was conducted by researchers at the University of Minnesota and the University of Wisconsin-Madison and published in *Chemistry of Materials*. To learn more, visit z.umn.edu/lithium

Students help public understand how microbes can clean the environment
Earth sciences assistant professor Cara Santinelli and her students show the public how their research using microorganisms can help clean up the environment. To learn more, watch: z.umn.edu/micro
CSE researchers work to restore structure and function of damaged tissues and organs.
f the promise of regenerative medicine is ever fully realized, it will rank right up there with the fountain of youth.

Regenerative medicine is a new and potentially transformational field of medicine that seeks to harness the body’s ability to heal itself, enabling its own cell-building processes to replace, restore, or regenerate dead, damaged, or diseased tissues and return patients to normal health.

“The idea is to harness the natural reparative abilities of the body to restore or maybe even replace a lost tissue function,” said Robert Tranquillo, a Distinguished McKnight University professor and head of the Department of Biomedical Engineering.

The results, scientists hope, are cures for diseases and injuries that now defy treatment.

"The holy grail of this would be if we could create a replacement piece of beating heart for patients who have had infarcts or heart attacks."
Regenerative medicine might take several forms, Tranquillo said. It might involve harvesting and manipulating a patient’s own cells and reintroducing them to the patient. Or transplanting cells from a healthy donor. Or injecting chemical cues such as proteins to induce the body to repair damaged tissues. Or—something Tranquillo is working on—implanting a collagen “scaffold” grown in the lab from a donor’s cells that will be transformed by the patient’s own cells into living, growing tissue.

Medical researchers imagine all kinds of benefits, Tranquillo said—healing torn ligaments and tissues, reversing arthritis, restoring lost vision, repairing the damage of Type I diabetes, and curing cancer.

“The holy grail for this would be if we could create a replacement piece of beating heart for patients who have had infarcts or heart attacks,” said Tranquillo, whose specialty is cardiovascular tissues. “If one could engineer a piece of beating tissue that actually had the ability to be vascularized or carry blood flow to nourish all those beating cells—that would have a huge impact.”

Scientists even contemplate creating organs for transplant or stimulating the body to replace organs as needed. “The sky’s the limit in some sense,” Tranquillo said. “That’s why we’re doing research. No one knows exactly what can work and what will work. But there are a large number of investigators who are working now on all of those things I mentioned and many more.”

Two years ago Minnesota upped its commitment to research when the Legislature created Regenerative Medicine Minnesota and allocated more than $4 million a year to research, education, patient care, and other initiatives. “It’s really going to have a big impact—it already has,” Tranquillo said.

State leaders plan to leverage Minnesota’s biotech expertise to grab a part of the quickly expanding global regenerative medicine market, which is expected to grow by more than 20 percent to $50 billion by 2020.

Grants are funding research at the University and Mayo Clinic on engineered blood vessels lined with stem cells derived from the patient to prevent blood clotting (Tranquillo’s project), regeneration of cartilage to repair

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**By the Numbers**

- Nearly 4,000 heart valve-related operations were performed in children age 15 or less in 2010
- $50 billion amount regenerative medicine market will grow to by 2020
- 200,000 people each year experience nerve injuries or disease
arthritic joins, retinal cell replacement to reverse macular degeneration, and many other projects.

“I’d like to underscore just how comprehensive the University of Minnesota is in doing this research,” Tranquillo said. “There’s an extensive infrastructure and expertise base right here, which makes Minnesota special for this kind of research.”

Read how three faculty in the College of Science and Engineering are pioneering regenerative medicine.

**ROBERT TRANQUILLO: Living Valves for Growing Hearts**

An adult with a heart valve defect may endure open-heart surgery to replace the malfunctioning valve with a mechanical replacement or valve from a pig.

A growing child, however, has it much worse. “That child would need two, three, sometimes as many as five open-heart surgeries as they continue to put in larger and larger valves, which, of course, is a devastating situation for the child and the family,” said Tranquillo. “So if you can make a valve that would actually grow and maintain its function, that would have a huge, huge impact for this particular patient population.”

That is what members of Tranquillo’s lab are trying to do—develop a heart valve that can be implanted once and, with the help of a patient’s own cells, grow with the patient.

Tranquillo’s work so far has been confined to sheep. He extracts sheep-skin cells called fibroblasts, a common cell that produces collagen and other fibers. He mixes the cells into a watery gel with a dilute network of fibrin protein fibers (the material that enables blood to clot) and pours the gel into a tubular mold. The cells multiply and exert traction forces to compact the gel, aligning and consolidating the fibers. The signals the cells use to then align with the fibers remain a mystery. Nonetheless, after about two weeks, the cells have created a tube with fibers and cells aligned around the circumference nearly one inch in diameter and two inches long, a bit larger than typical rigatoni.

Unfortunately, the engineered tube is far too weak to implant as a vessel or valve. So Tranquillo puts it in a bioreactor to stretch it repeatedly while bathing it in nutrients. “We feed them and we exercise them,” he said. “The cells are getting stimulated to produce collagen and other proteins that they deposit in this matrix of aligned fibers. After several weeks, the engineered tube has the stiffness and strength of a native artery or heart valve, sometimes even stronger.”

Now comes the counterintuitive part—after the cells have built up this tube, Tranquillo strips them out with detergent, leaving only the collagen. He then stitches one tube inside another over a small frame to create something that looks like the heart’s tricuspid valve. Fluid blows through the valve in one direction, but pressure from the other direction causes the end of the inner tube to slam shut.

Tranquillo has transplanted these tissue-engineered heart valves in sheep for up to six months. The sheep’s body rapidly deposits cells on the structure, creating a living tissue, a result of the regenerative processes induced by the properties of the engineered matrix tubes from which the valves are constructed. One big question remains: Will the valve grow?

Tranquillo anticipates clinical trials in humans will be possible soon. “I would say we’re very close to one that would work for an adult,” he said. “The harder problem is trying to make a valve that works in kids, because unlike the adult, of course, the valve needs to be able to grow to have a big impact.”

A close-up of the “tissue engineered” heart valve that can be implanted once and, with the help of a patient’s own cells, grow with the patient.
MICHAEL MCALPINE: Channeling New Nerve Growth

Michael McAlpine just happened to land in the field of regenerative medicine. His real interest is 3D printing. McAlpine, the Benjamin Mayhugh associate professor of mechanical engineering, has 3D-printed everything from three-dimensional electronics to a soft bionic ear embedded with a conducting silver radio antenna. His current project is a 3D-printed silicon tube that guides the regrowth of nerves in complex patterns.

Each year, about 200,000 Americans suffer significant nerve damage from disease (such as diabetes), accident, or even battlefield injury. McAlpine’s
“Nerves are the wiring in your body for transmitting information,” McAlpine said. That information goes both ways—transmitting sensations to the brain and carrying instructions to extremities for motor function. If nerves are damaged, McAlpine said, “you can lose the ability to feel or, worse, the ability to move.”

“The standard fix for a destroyed nerve is to take a healthy nerve from somewhere else in the body and suture it into the cut region and restore function that way. The problem is that you then have to sacrifice a healthy nerve from somewhere else and have a second operation to obtain that nerve,” McAlpine said.

But what if nerves could regenerate themselves? Actually, they can. But their capacity to do so is limited, and they need some help. Here’s where McAlpine’s expertise in 3D printing comes in.

McAlpine used lab rats and scanned their sciatic nerves, the major branching nerves that control the back legs and often serve as stand-ins for studies on nerve injury, regeneration, and recovery. From each scan, McAlpine 3D printed line after line of silicone, building a branched tube of silicone, where the branches exactly matched the branching of the nerves.

He then removed a half-inch section of the rats’ sciatic nerves on one side and sutured the severed ends into the ends of the silicon guide. The rats limped badly at first, as expected. But within three months, the nerves regrew and joined inside the tubes. The rats ability to walk again was improved.

Researchers have used tubes like this before, McAlpine said. But his lab was the first to replicate the nerve branches with a 3D printer. In addition, the 3D printing produced “bonus features.” The process resulted in tiny grooves, which ran the length of the branching tubes. “We used those to our advantage,” McAlpine said. “Those grooves actually tell the nerves which way they are supposed to grow. They grow along those grooves.”

McAlpine also printed “capsules of bio-molecules” such as proteins into the tubes to “facilitate the nerve regrowth. The goal is to direct motor nerves to go one way and sensory nerves to go down the other branch,” he said. “This combination of 3D scanning and 3D printing opens up a whole new avenue.”

SAMIRA AZARIN: Building a Cancer Cell Collector

Much of Samira Azarin’s research falls within the realm of tissue engineering—using cells to build tissues in the laboratory, and she is focusing on several research projects.

Azarin, an assistant professor of chemical engineering and materials science, directs adult-derived stem cells to “manufacture” the endothelium (blood vessel) barrier that separates much of the body’s blood chemistry from delicate brain tissues. This engineered tissue could be used in research and drug...
Samira Azarin, assistant professor of chemical engineering and materials science, studies the role of the cell microenvironment in development of healthy and diseased tissues for applications in regenerative medicine and cancer therapeutics.
testing, potentially reducing the need for animal studies. “If you are trying to figure out if a drug crosses the human blood-brain barrier, you can potentially screen that on these cells versus having to use mouse models,” Azarin said.

In a similar endeavor, Azarin stimulates adult-derived stem cells to become heart muscle cells. Unlike many cells in the body, which multiply rapidly to heal an injury, heart cells barely regenerate. That’s why muscle damage from a heart attack is considered permanent. Azarin wants to use her manufactured heart cells to model the behavior of natural human heart cells. “Is there a way we can turn them back on again to repair heart tissue?” she asks.

In a third project Azarin turns regenerative medicine on its head, implanting a polymer disc under the skin of mice with breast cancer to stimulate a mild immune reaction and create not healthy tissues—the goal of most regenerative medicine—but a tissue that mimics the environments cancer cells encounter once they leave the tumor and spread to metastatic sites in other organs.

Since the mouse’s breast tumor has co-opted the immune system to send immune cells (which actually protect the cancer) to various sites in the body to prepare them to receive more cancer cells, the immune cells also end up in the tiny disc. “Those immune cells secrete chemical signals that can cause migration of tumor cells to the site. They also secrete factors that can ready the environment—preparing the soil, as we call it, for the cancer cells,” Azarin said.

“This really ties into our vision of regenerative medicine,” she said. “We thought we were going to have to put a lot of stuff on this scaffold to bring in cancer cells—all these bells and whistles. And it turns out when we put the device in, even just the simplest device in, the body does a lot of the work for us.”

But why create a precancerous environment in a body, in rodents or in humans?

By creating a magnet for circulating cancer cells, Azarin has created an early-warning system for cancer recurrence. After undergoing breast cancer treatment, a patient could have such a disc implanted. “You could have this device regularly scanned and look for the presence of tumor cells,” Azarin said. In addition, by preventing a portion of the cancer cells from going to other places, like the lung or the brain, these implants can act as a therapeutic “sponge” to soak up harmful cancer cells.

Azarin is also investigating whether the discs can be used to treat prostate, melanoma, ovarian cancer, and pancreatic malignancies. “There’s certainly great potential to have an impact across many types of cancer,” Azarin said.

“When implanted in the body, these therapeutic sponges “soak up” harmful cancer cells. The sponges will likely be used by patients who have had a tumor removed and are in remission, to make sure their cancer doesn’t return.”
It is a truism— if not an outright cliché—the world is becoming ever more connected.

No longer is it only possible to pick up a phone and instantly reach someone living on the other side of the world. Now we can post a video on YouTube or a comment on Twitter and have them, potentially, viewed instantly by any of the billions of people currently hooked up to the Internet—all but a handful of them complete strangers to us (and to each other).

But not only is the world increasingly connected, it is also increasingly interconnected. Once separate, autonomous enterprises, agencies, businesses and institutions are now interwoven into that same web of cyberspace that lets us display photos of our kitten on Facebook. In turn, that keeps raising the level of exposure of those previously autonomous entities to the risk of cyber attack. These can originate from amateur hackers motivated by nothing more complex than the wish to play a good prank, to companies and countries seeking to steal proprietary information or get a jump on their rivals, to terrorists hoping to wreak havoc on power grids, water treatment systems or nuclear weapons programs.

Trying to prevent that from happening is the Technological Leadership Institute (TLI), a multi-disciplinary center within the University’s College of Science and Engineering whose degree programs focus on technological security, with cyber security as the centerpiece.

Massoud Amin, professor of electrical engineering and the director of TLI, is a noted expert on security and technological innovation. Regularly consulted by government agencies and industries, Amin is known as the “father of the smart grid,” the secure overlay of sensors, communications, and automation devices that can
As director of global security at SPS Commerce, Inc, Milinda Rambel Stone (MSSE ’99) manages secure software services for the company’s 65,000 retail customers.
detect pending disruptions (whether intentional or natural phenomena), stop them, and then heal themselves automatically. Smart Grids are now global undertakings that he has developed and led since the 1990s.

On Sept. 11, 2001, Amin was about a mile from the Pentagon giving a briefing to the White House and other agencies on detecting and preventing catastrophic failures of our nation’s critical infrastructures. In the wake of that calamity, he directed all security Research and Development for all North American utilities, and was promoted to direct all grids operations and planning, infrastructure security, energy markets, risk and policy assessment at the Electric Power Research Institute (EPRI) in Palo Alto.

According to Amin, TLI has more than 1,200 alumni of its Master of Science degree programs in every sector of technology, industry and government, including 140 alumni of the Institute’s Master of Science Security Technologies (MSST) program working in Minnesota alone. Others have gone to cyber security careers in New York, D.C., Houston and elsewhere.

“Our alumni are making pivotal contributions in many areas including critical infrastructure protection and cyber security,” said Amin. “One can only accomplish this type of transdisciplinary deep expertise combined with wide-angle talent and leadership development within the context of an interdisciplinary institute that has a 30-year proven track record of creating and delivering industry-responsive programs, in judicious areas that really matter.”

In addition, the Department of Computer Science and Engineering offers a masters of software engineering (MSSE) degree. The curriculum delivers a blend of software engineering theory and practice. Many courses focus on computer security, quality, assurance, and safety-critical systems.

Administering the MSSE program through the University’s Software Engineering Center is Mike Whalen, who is program director. The center works to address issues that impact all sectors of society through research, education, and outreach.

“Software is critical to our infrastructure,” Whalen said. “The world relies on it—it has to be right.”

The following stories about four College of Science and Engineering alumni highlight their role in keeping us safe from cyber attacks.

**MILINDA RAMBEL STONE: Growing security needs**

With more than 20 years of experience in creating and managing large-scale information security programs in manufacturing, healthcare, education, and financial services, today Milinda Rambel Stone (MSSE ’99) puts that expertise to work as Director of Global Security for SPS Commerce, Inc. The company’s retail network provides software services to more than 65,000 retail companies that range, Stone says, from Best Buy down to very small operations.

“For any retail company buying or selling something online or in physical stores, we can provide solutions to manage their agile supply chain,” she said. “We are all about processing everything about the order except for payment.”

Stone says her position was created in 2014, and she was hired for several critical reasons.

“SPS was growing at such a rapid rate that the company decided it needed someone to build a department dedicated to online security,” she said. “I’m the person building that department. We started with zero people less than two years ago and now have six full-time employees and a significant number of consultants working with us.”

“The most significant challenge is keeping pace with the growth of online retail sales. We need to make sure that we are securing our systems in the right way, staying ahead and committed to staying ahead. That's a real opportunity because online activity is so high.”

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*MILINDA RAMBEL STONE*
“My role here is cross-disciplinary. I work with many different departments,” she said. “I like to say I touch the work of everyone in the company.” Stone’s official SPS position summary and list of responsibilities seem like enough to keep a small army of online security experts scrambling to keep up.

“The most significant challenge is keeping pace with the growth of online retail sales,” Stone said. “We need to make sure that we are securing our systems in the right way, staying ahead and committed to staying ahead. That’s a real opportunity because online activity is so high—and getting higher every day—and threats come in from the outside or internally from mistakes,” she said.

“By the nature of the job, you have to be proactive, figuring out where the risks are coming from today—and where they’ll be coming from tomorrow,” she added.

Stone came to SPS by way of her love of software engineering. After receiving a master’s in business administration, she went into consulting, and was then hired by a bank where her job was to develop systems to detect banking fraud and protect customers.

“I was hooked,” she declares. “I was at the intersection of software engineering and security.” She earned another master’s degree in 1999—this one in software engineering from the University—and was hired by SPS to apply her combination of education and experience to the company’s own security needs.

“One of the things I’m doing now is automating security controls to make sure that our software is building security into itself and has the ability to detect anomalies or suspicious activity,” she said. “It’s called continuous control monitoring automation.”

“I never thought I’d be doing software engineering and security at the same time. It’s my dream job!”

**DAN MCKEOWN AND LAWRENCE WELLS: Building a cyber security unit**

Dan McKeown (MSST ’14) and Lawrence Wells (MSST ’15) were hired as contract employees by Optum, the technical and networking arm of health industry giant UnitedHealth Group (UHG), in the fourth quarter of 2014. In the beginning of 2015, they became permanent employees. Optum was about to create an internal cyber defense organization with a large enough staff to handle all networking,

**By the Numbers**

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<th>121%</th>
<th>20,000</th>
<th>$445 billion</th>
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<td>cybersecurity industry will grow globally over the next five years</td>
<td>open information security jobs across the U.S. in 2015</td>
<td>amount cybercrime costs the global economy each year</td>
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information risk management, and technical issues across the entire span of UHG’s many divisions and offices.

Given the title Senior Information Consultants, McKeown and Wells were the first additions to this new cyber defense unit, Security Operations Central (SOC). Shortly after they came on board, the Optum manager who had hired them left the company for another team that was being built up within the cyber defense organization. The brand new—and only—members of SOC found themselves faced with hiring and training the unit’s team. And, in addition to training those new team members, writing and implementing all the new security processes and procedures, from risk assessment and response to liaison with other UHG units.

The irony of the position he and McKeown found themselves was not lost on Wells. “Here we were the two new kids on the block and suddenly we were in charge of things,” he said.

Wells and McKeown began by interviewing and hiring new personnel. With that underway, the pair began to train their staff in UHG’s network systems and overall organizational structure.

“The fun part was we both got hired on as a team and then turned around to hire our team and train it even as we were learning the company’s systems and environment ourselves,” Wells recalls. “We had a lot of help but it was still a big challenge.”
Once the “fun part” was over, Wells and McKeown moved on to develop processes and procedures for cyber incident detection, response, and remediation. Over time, the team has developed even more carefully targeted processes and procedures designed to respond specifically to UHG’s wide-ranging network needs.

Today the SOC employs 40 individuals—30 based in the United States and 10 in India.

Why the exponential growth of the unit?

“UHG is the largest health provider in the U.S. and one of the largest in world,” he said. “It is a Fortune 6 company that is continually adding new companies to its corporate family.”

For example, he cites UHG’s recent acquisition of Catamaran, one of the world’s largest prescription management companies. “UHG is an insurance company, a bank, a pharmaceutical company—it does just about everything related to health care,” said Wells.

The size, scale, and complexity of UHG bring unsurprisingly, equally complex and large-scaled cyber security needs.

For Wells, the road to cyber security came by way of the military. He served as a petty officer in the U.S. Navy, working with the sonar team aboard a ship that carried guided missiles.

“There were security issues built into everything we did and everything I was doing was secret,” Wells said.

“In the SOC, we monitor security events. We look at logs and ongoing events on all of our networks, all input and output, firewall logs, intrusion detection systems—everything. Our job is to prevent things that might show up in the headlines. We don’t want to be on the news for this kind of thing.”

As computers and, in particular, computer networks quickly became a ubiquitous reality in both the public and private sphere so did “real cyber security issues.”

Once out of the Navy, Wells transitioned into network administration. That pursuit led him to create ad hoc cyber security systems to protect the servers at the companies where he went on to work over the next nearly 20 years.

Meanwhile, McKeown got his start in cyber security early in life.

“I started playing with computers when I was very young and building my own,” he recalls. “By the time I got to high school and saw movies like Hackers, I wanted to be one of guys breaking into networks.” One day it clicked for him. He could be one of those hackers. “Then I realized I could use the knowledge I learned from hacking to protect online interactions,” he said.

“As UHG brings on individual companies not all have the same security needs or network structures that we do,” he said. “We have to go into their network environments, take a look at their security postures and find a way to integrate them in into our system.”

“In the SOC, we monitor security events. We look at logs and ongoing events on all of our networks, all input and output, firewall logs, intrusion detection systems—everything,” he said. “Our job is to prevent things that might show up in the headlines. We don’t want to be on the news for this kind of thing.”

At Optum, McKeown and Wells lead a team that works on more common kinds of risks and threats to ones that Wells describes, with a touch of admiration, as “artistic.” In any case, the two men and their colleagues have built—and continue to develop—cyber security systems that not only have the intelligence to detect threats built right into them but also to be self-healing when there is a security event of any kind.

“Cyber defense is a combination of tools and intelligence analysis,” observes Wells. “Our job at Optum is
Phelix Oluoch (MSST ‘15), senior information assurance engineer, works on cyber security for Chevron Oil and Gas, preventing, identifying, and mitigating security incidents.
to develop the software and personnel judgment to be able to identify risks and remedy them before they pose a threat to our networks.”

PHELIX OLUOCH: Keeping ahead of attackers

Phelix Oluoch (MSST ’15) is a Senior Information Assurance Engineer for Lockheed Martin’s industrial division. He works on cyber security for Chevron Oil and Gas, which contracts for his services. In the future, he expects to be working under the same arrangement, but for NASA, perhaps, or Boeing.

At Chevron, Oluoch is part of a team tasked with a number of crucial cyber security responsibilities.

“In a nutshell I work with several senior security analysts to prevent, identify, and mitigate security incidents,” he explains. “That includes the monitoring of communication and cyber incident response. The job also has an intelligence aspect—threat intelligence and analysis.”

What this means in practice is that Oluoch is involved in preventing, identifying, and resolving “information security incidences.” He offers an illustration of the kind of work he’s engaged in.

“What we do is use a set of information security technologies including SIEM [security information and event management] tools,” he explains. “These are layered hard and soft sensors on a network that detect security anomalies. When one is triggered, we look at the event, analyze, and triage the incident as necessary.”

The most common problems he encounters are phishing, malware, social engineering, and, occasionally, what he calls “opposition intelligence.”

“Most of these problems are what we call APT [Advanced Persistence Threats],” Oluoch explains. “In most cases there is an involvement of a nation-state—like China—in an attempt to steal intellectual property and other information that can be used to gain a competitive business edge against Chevron.”

What does he like most about his job? “The challenge,” he said. “There’s almost always something new—and what I mean by that is attackers are always changing their tactics.”

“It’s a cat-and-mouse chase. We keep remodeling the security technologies to prevent or detect what attackers are trying to do. That might be either new malware or new phishing methods—techniques for compromising a computer system in order to insert malware into the system. In some cases, that might involve something as simple as an email tricking the recipient into clicking on a link that downloads malware that breach security measures,” he said.

Another common technique is to send MS Word files that have malicious macros.

“Once you enable macros, the stage is set for all sorts of malicious activities,” Oluoch observes. “The bad guys can use a compromised computer as a pivot point into the company network. Once in the network, they can steal sensitive and other information, security credentials and even elevate their access levels to do more damage.”

“The game is always changing,” he says. “That’s what keeps it interesting.”

It’s a cat-and-mouse chase. We keep remodeling the security technologies to prevent or detect what attackers are trying to do. That might be either new malware or new phishing methods—techniques for compromising a computer system in order to insert malware into the system.
Hands-on work experience, academic credit, mentorship from working professionals, enhanced networking skills, hourly pay of $18 or more—there are lots of good reasons for students to participate in the engineering co-op program.

One of the biggest reasons? Co-op students give themselves a critical edge in the post-graduation job search process, said Frank Kelso, director of the engineering co-op program and a teaching professor in mechanical engineering. “Some employers tell us they actually don’t hire candidates unless they’ve been co-op students,” he said. “Power Engineering and Manufacturing (PEM) is one of those employers.”

Jim Blesener (EE ’87), vice president of engineering for PEM, said that on the rare occasion PEM does hire an aspiring engineer who didn’t participate in the co-op program, the company requires the new hire to do a co-op.
“The University teaches you all the important theory,” Blesener said—and then in the co-op, the rubber meets the road. “You learn about the bill of materials, how to communicate with manufacturing, how to work with a supplier. It’s a very valuable program.”

He knows that from the student’s perspective as well as the employer perspective. Blesener was a co-op student himself 30 years ago. The program’s been in place since 1950. Some of the 35 participating companies are staffed by multiple generations of former University of Minnesota co-op students. Current co-op employers include Andersen Windows, Medtronic, and Xcel Energy.

The program serves students majoring in mechanical engineering, computer engineering, electrical engineering, and as of this year, industrial and systems engineering. Unlike an internship, which usually lasts a summer and doesn’t provide academic credit, a co-op typically stretches over multiple semesters, giving students a deeper, more intensive full-time work experience.

“Co-op students are practically working engineers,” Kelso said. “And they earn technical elective credits that count toward graduation. That’s not the case at most other universities offering engineering co-ops,” he added.

Co-op students—usually juniors, sometimes seniors—work 40 hours a week. “You take a 13-credit waiver, which means you’re still a full-time student,” even though you’re not taking classes during that time, Kelso explained. Pay averages about $18 an hour. In some cases, students earn $20 an hour or more.

The application process is fairly involved and quite competitive. It begins with a job fair early in the semester. Companies send recruiters to provide information and answer students’ questions about their business. “Students try to get a feel for what it would be like to work at different companies. Everybody exchanges cards, the students hand out resumes,” said Kelso.

Next, after interviewing in person with multiple companies, students create a ranked list of their favorite prospects—and the companies do the same. Then Kelso and colleagues go through those lists and try to act as “matchmakers.”

Often (though not always), doing a co-op means taking an extra semester, or even an extra year, to graduate. Kelso tries to persuade students it’s well worth it. “A lot of companies, if you don’t have work experience, they’re not even going to look at your resume,” he said. “I tell them if they can get some experience now, they can have their pick of jobs.”

Brian Amundson, a May 2016 mechanical engineering graduate, remembers the pride and satisfaction he felt one day toward the end of his co-op with MTS Systems Corporation, a global testing solutions company. He’d been working on designing a part for a road simulator that tests cars and trucks for durability—a flexure that sits, horizontally, on the actuator that controls the vertical bump force. The part’s predecessor had been plagued with maintenance problems.

“It had to absorb the reaction of that actuator firing, up to 50,000 pounds pushing or pulling, and it had to flex and bend,” Amundson said. His idea took months to perfect. About two weeks before his three-semester co-op ended, Amundson got to see his baby.
"The biggest highlight for me was when this flexure finally showed up—the machined steel part that was going to be tested," Amundson said. "All the work I'd put in, and then, here is the part. That was really rewarding for me."

That was last spring. A few months later, Amundson, who is from Le Sueur, Minn., heard the part had survived its first round of testing. "They called it good," Amundson said with a smile. He’s grateful for the experience. Even though Amundson will graduate a year later than he might have, "the experience you get in a co-op goes so far beyond what you’re able to get in the classroom."

Amundson’s co-op was structured a little differently than many. He alternated semesters at the co-op, in classes, and then back at the co-op. "I was switching out with another [co-op] student," Amundson explained.

Because he loves vehicles of all kinds, MTS was one of Amundson’s top choices for a co-op. "Driving has been my passion since I was 10 years old on a go-kart. Golf carts, jet skis, motorcycles, snowmobiles, you name it," Amundson said. (He was cofounder and cochair of the U’s Clean Snowmobile Team.)

But he recalls when he left his interview at MTS, he thought he’d blown it. “To be honest, I thought that was my worst interview. I was pretty upset when I left," Amundson said. “Most companies would do a resume run-through and go over the HR packet. The MTS interviewer handed you parts. They’d pick up a part that had failed on some machine, give you a little bit of background, and then say, how would you fix this? Which was really intimidating—especially as a sophomore.”

It was a growing experience, like the co-op itself. "I tell students all the time, 'Do a co-op. It makes you so much more marketable to employers.' I had a phenomenal time at MTS,” he said.

MADELINE FLANDRICK: Medical manufacturing
Enticed by different aspects of different companies, Madeline Flandrick, a student in industrial and systems engineering, was struggling to decide where she’d most enjoy doing her co-op. An in-person tour of one prospective employer’s plant sealed the deal.

“I don’t think I would have picked Heraeus,” a German-based company whose U.S. medical components production site is located in White Bear Lake, Minn. “Then I toured their facility. When I got to see how they do everything and the cool robots they use, that really swung my decision,” Flandrick said. “I was pumped.”

Her co-op, which started in January 2016, is Flandrick’s first exposure to medical devices, and she loves it. "Heraeus makes electrodes, coils, implantable housings, guide wires, and other components and assemblies for the world’s most influential medical device companies," she explains. “Right now the project I’m working on involves leads for pacemakers—the parts are tiny so you have to use a microscope to look at them.”

It’s wildly different from the manufacturing engineering internship Flandrick did in summer 2015, working for a company that makes railroad cars. That’s by design, she said.

“I enjoyed myself in the internship, but I wanted to see what other fields could offer." She’s also getting a work experience that more closely resembles a professional job, with the responsibility and sense of satisfaction that comes with it.

In a co-op, Flandrick said, “you get to see a project from the very, very beginning to the very, very end. You get to see how the whole process flows. You also have time to figure out how everything works and get to know all the people you work with.

“"There’s nothing more important than the work experience you can get from a co-op, because it’s priceless. I really like starting to understand how the things I’m learning in school can be applied in the real world."

MADELINE FLANDRICK"
Madeline Flandrick, an industrial and systems engineering major, learned about manufacturing the components that make up medical devices at her co-op with Heraeus in White Bear Lake, Minn. Flandrick is also recipient of the Glenn E. Ullyot Scholarship and Larry W. Rothenbuhler Scholarship.

“In my internship, I didn’t feel really comfortable until the very end of the summer—and that’s when you have to leave,” she said.

The benefits of that extra time spent flow both ways, she adds. “It’s not just that you get to work longer and have more experience, but they get to have you longer—and you’re ultimately more useful to the company,” Flandrick said.

One of Flandrick’s roles is to serve as a liaison between the plant’s operations team and the engineers. “Operators will come to me with a question or a problem, and if I don’t know how to solve it, I’ll talk with the engineers and we’ll come up with [a solution],” she said.

“We just sent out our first parts last week,” Flandrick said proudly. “So now we’re working to perfect the process and make sure we can send the rest of the parts out on time.”

Flandrick would recommend the co-op program in a heartbeat. “There’s nothing more important than the work experience you can get from a co-op, because it’s priceless,” she said. “I really like starting to understand how the things I’m learning in school can be applied in the real world.”
ANATOLE WIERING: Machine upgrade

Anatole Wiering, an electrical engineering student, took an alternative path into his co-op at Kohler Co., the Wisconsin-based manufacturer of kitchen and bath products, engines and power systems, and furniture and cabinetry.

He was approached by his high school mentor, a longtime Kohler employee, and encouraged to apply for a position. Gaining approval from the University’s co-op program was a “piece of cake,” Wiering said.

“I had to contact the co-op program here to make sure everything would work out, because I wasn’t applying through their process,” Wiering said. “There was one small glitch, but it was easily handled. If you’re able to coordinate with a hometown employer on your own, [the U] will allow you to do it.”

Wiering, who is from the Manitowoc-Two Rivers area, had interned at Kohler the summer after high school.

During his co-op experience, Anatole Wiering, who is studying electrical engineering, worked on upgrading a machine for the small engine assembly line at Kohler Co. in Wisconsin. Wiering is also recipient of a 3M Scholarship.
graduation. The co-op he landed was very different.

“I worked on the manufacturing side, in maintenance. We worked on maintaining a lot of custom-built machines, and a couple new installs as well,” he said. In contrast to a summer internship, the co-op gave him ample time to learn and then to delve into his own project.

In an internship, “you need to take that three months to learn what’s going on,” he said. “With the co-op, you then have another four months to apply that. So you can actually contribute.”

“In the beginning I just tagged along with them. They showed me a lot about the basics of what they do. Near the end, I was working quite a bit more independently,” he said.

One of Wiering’s projects was to work with a mechanical engineering co-op student (from a Wisconsin university) to upgrade a machine on the assembly line for small engines. “I designed the control panel and worked on programming the design for the integration,” Wiering said. “I worked with the mechanical engineering co-op student every step of the way to make sure it worked as we expected.”

“They were using it on the assembly line before I left,” he said with a smile. “Initially I thought, this is a pretty big challenge because of the [limited] time I had left. I wasn’t sure I would finish. But we did—and it was great to see it work.”

His other main project at Kohler was just as gratifying. “It was a large, long-term project that involved a lot of debugging and testing. It took a long time to finally get that working. I probably put more than 100 hours into the project, most of it by myself. Getting it working smoothly was great.”

In the beginning I just tagged along with them. They showed me a lot about the basics of what they do. Near the end, I was working quite a bit more independently.

ANATOLE WIERING
Endowed chairs and professorships give CSE academic strength

It’s long been known that interactions between field-shaping faculty members and their students have a profound effect on the quality of the educational experience. Undergraduate and graduate students alike benefit from the knowledge and guidance of faculty who are not only top researchers in their field, but also outstanding teachers. As students learn in the classroom and work side by side with faculty in the lab, they acquire the knowledge they need to solve pressing problems now, as well as into the future.

One key is to create an environment of teaching excellence to recruit and retain top research faculty through endowed faculty professorships and chairs. These faculty members represent the best minds, the most creative researchers and the most engaged teachers. They enrich the academic environment, which in turn attracts the best and brightest students who will become the world’s next generation of innovative scientists and engineers.

Hartmann endows chair
Recently, Robert Hartmann (EE ’65), one of our most generous alumni, made an investment in the college by endowing the Hartmann Chair in the Department of Electrical and Computer Engineering. He also provided his thoughts on giving.

“People give to various causes in different ways. Some, like me, give money. Money is great because it is fungible. Everyone likes it because it can be used to solve a large variety of problems. We give to causes because we believe we can make a difference. It might be to alleviate hunger, it might be to provide health care for people who have no other options, it might be to save parts of wild lands or endangered creatures; all good causes and worthy of contributions. I believe financial contributions to improve and increase education at all levels is the most efficacious way to long-lasting improvement of human society. First, it’s a way I can say ‘thank you’ to the University of Minnesota and to all those who had a hand in my great education at an affordable cost. Secondly, it’s a way to ensure that the College of Science and Engineering can continue to be an outstanding institution of higher education.

“I am especially proud to support the Hartmann Chair and its first recipient, Professor Jian Ping Wang, a world-acclaimed expert in the field of nanomagnetism and quantum spintronics. This appointment adds to the stature of the University of Minnesota, which I hope will attract even more—and better—students and faculty and perpetuate continued academic strength at the University.” - Robert Hartmann

Professor Wang’s research interests
Wang’s chief research interest is spintronics, which uses the “spin” of an electron rather than its charge. Using the technology, he invented a biosensing device that quickly and accurately measures even a tiny quantity of a disease or health condition in a human sample. The invention could detect biological calling cards for diseases like HIV, HPV, ovarian cancers, and breast cancers.

His research has led to 200 scientific publications, 39 patents, and three start-up companies. He earned global attention for his research in Fe16N2, a potential powerful rare-earth-free magnet that could replace expensive and less environmentally friendly rare earth magnets in wind turbines, motors, and generators. His inventions have also been used in the development of hard disk drives.

Not only is he an outstanding researcher, Wang is a great teacher, receiving the outstanding professor award for his contribution to undergraduate teaching in 2010.

Support like Bob Hartmann’s is essential to our education and research mission and to keeping the college top-ranked. If you would like more information about how to support faculty and students, please contact me at 612-626-9385 or dockter@umn.edu.
What Drives Your Curiosity?

Ken Wuollet
Zimmerman, Minn.
Ed and Cora Remus Scholarship recipient

Work hard, earn good grades, graduate, and build a successful career—that's what Ken Wuollet intended to do when he entered North Hennepin Community College in fall 2000. Yet, by the end of his first year, his grade point average had slipped to 1.6. "I had no direction or drive, so I dropped out," said Wuollet.

Over the next 10 years, Wuollet found work in the construction industry, married, and moved to Zimmerman, Minn. Several children later, he ended up with Highway Technologies as a crew leader painting strips on roads. "It's honest work, and I've been successful. But after 10 years, I needed a change and more challenge," said Wuollet.

Wuollet decided to take another stab at school. In the spring of 2011 at the age of 29, he enrolled at Anoka-Ramsey Community College in Coon Rapids, Minn. "It was a totally different experience than the first time," he acknowledges. "I was definitely more focused.

His determination paid off. After two years at Anoka-Ramsey full-time, his grade point average had climbed to 4.0, all while working full-time— evenings and weekends— as his wife took care of the homefront. He had also added two more children to the family.

Accepted into the University
With enough credits under his belt to qualify as a junior, Wuollet applied to the University of Minnesota. He was accepted as a transfer student and began his studies in the fall of 2013.

Wuollet initially thought about majoring in civil engineering because of his construction experience but soon discovered he had an aptitude for chemistry. "I finally decided on chemical engineering because I wanted to combine the problem solving aspect of engineering," he said.

As Wuollet got deeper into his major, the classes became more difficult. Every day was occupied with studying, working, and balancing the needs of seven children, his wife, and home. He was also traveling 45 miles each way to and from school. "My classmates would wonder what they were going to do on the weekends, and that was so foreign to me," he said. "My life was broken down into scheduled increments, sometimes even one hour at a time," he said.

Receiving scholarship help
Wuollet learned about available scholarship help, applied, and received the Ed and Cora Remus Scholarship. "I was grateful, as it really alleviated some of the financial stress. It also meant I could focus more on school, and less on work," he said.

In spring 2015, Wuollet got to meet his benefactors, Ed and Cora Remus, who live in Geneva, Ill. Remus, a 1965 chemical engineering graduate, and his wife were back on the U of M campus to attend a CSE reunion event. Remus noticed that there were similarities in both their educational paths. "I also started out in junior college before I came to the University," he said.

Remus joined Sinclair Research as a research chemical engineer after graduation and later decided he wanted to pursue a law degree. By the time he entered law school, he was married and had a family. "I was going to school during the day while working at night, so I could identify with Ken's situation, and it's not easy," he said. "We also learned we both were of Finnish ancestry."

After their meeting, and learning more about how Wuollet was trying to balance everything, the Remus' decided to double their scholarship funds.

"My Finnish mother would often use the term 'Sisu' to describe someone with stoic determination, guts, or resilience," said Remus. "Ken was someone who displayed that quality. In our eyes, our scholarship funds could not have been put to better use."

Wuollet graduated this past spring with a 3.65 grade point average and is now serving as Operations and Project Manager at Sir Lines-A-Lot, while still looking for an engineering opportunity. "I've learned you can do anything if you persevere," said Wuollet. "Higher education opens doors and opportunities. With scholarship support, it made things much easier."

The Wuollet family
3M scholarship helps to attract students from underrepresented groups

The College of Science and Engineering’s largest corporate donor, 3M, is helping the college increase the number of students from underrepresented groups with a diversity scholarship.

Last year, the company established a diversity scholarship that allocates $400,000 to cover tuition expenses for undergraduate students in CSE. The four-year renewable scholarship awards $10,000 each to 10 students from underrepresented groups who are majoring in chemistry, chemical engineering, or mechanical engineering. This past fall, 10 underrepresented students from locations across the country received the first scholarships. By fall 2016, 20 students each will be funded at $10,000 for four years.

Student numbers have grown steadily in CSE for the past few years, and the University of Minnesota’s overall goal is to more than double the number of students from underrepresented groups by 2020.

Research shows that diversity enriches the educational experience. Learning with students from a variety of backgrounds encourages collaboration and fosters innovation, which will benefit all students and eventually make for better employees.

According to Susan Kubitschek, CSE assistant dean, many universities nationwide heavily recruit top students from underrepresented groups. “With these 3M scholarships, the University of Minnesota is able to recruit high achieving diverse students by offering them a very attractive financial package to choose CSE.”

3M is one of the most engaged companies on the University of Minnesota campus, and consistently one of the top employers of CSE students. In 2015, 30 undergraduate alumni identified 3M as their employer making them the number one employer of 2015 CSE graduates.

In addition, 3M holds more interviews at the College of Science and Engineering than any other company, recruits across every major, and draws a high number of applicants. The company has an active presence at CSE’s career fair and also helps out at events such as career panels, Practice Interview Days, and the college’s Resume Marathon.

Many programs and initiatives at the University of Minnesota would not be possible without 3M’s generous support. Over the past several decades, 3M has given more than $65 million to the University of Minnesota, and nearly $19 million to the College of Science and Engineering for student scholarships, leadership programs, hands-on experiential learning opportunities, K-12 outreach, state-of-the-art facilities, and more.

"Through our partnership with 3M and its generous contributions, we are able to deliver a world-class education for CSE students who will become the next generation of scientists and engineers," said Steven Crouch, outgoing dean of the College of Science and Engineering, "We are grateful for their support."
A new scholarship endowment—the Steven L. and Karen L. Crouch Endowed Scholarship Fund—has been created by the CSE Dean’s Advisory Board to recognize Crouch’s long-term service to the college as dean.

Ronald L. Christenson, chair of the Dean’s Advisory Board, said the board created the scholarship as a fitting way to honor his legacy for future generations and to celebrate his commitment to undergraduate education. “Under Steve’s leadership, the College of Science and Engineering has produced more than 15,500 science and engineering graduates, many of whom are now in leadership positions around the world,” he said.

The scholarship, funded with an initial contribution of $100,000 by board members and CSE campaign volunteers, will be used to provide scholarships for College of Science and Engineering students.

Crouch’s legacy

Under Crouch’s leadership, many initiatives have truly made the College of Science and Engineering an extraordinary place. Some examples include:

• The number of CSE undergraduates has grown by more than 39 percent over the past 10 years.
• The demand for admission to the college has more than quadrupled, with nearly 14,100 applicants for about 1,100 seats. Today’s CSE student enters the college with an average ACT score of 31.5.
• The number of scholarships awarded to deserving students has nearly doubled, and the average amount awarded has increased by nearly 42 percent. The total amount of scholarship money awarded in 2008 has grown from more than $790,000 to $2.3 million this past year.
• The building projects for the college—more than $350 million—include the new Physics and Nanotechnology Building, Amundson Hall’s Gore Annex expansion, the Lind Hall renovation, and the current renovation of John T. Tate Hall.

“Karen and I are humbled and we are grateful to have a named scholarship in our honor,” said Crouch. “Having had the good fortune of working with an outstanding team of faculty and dedicated staff, I am proud to have served as leader for what I believe is the best college at one of the best universities in the country.”

If you would like to make a gift to the

Steven L. and Karen L. Crouch Scholarship

please visit The Steven L. and Karen L. Crouch Endowed Scholarship Fund at:

z.umn.edu/crouch
(enter Fund 21341 Crouch Scholarship in the “Other” box).
One of the smartest decisions Stephan Perera (ChemE ’16) ever made as a College of Science and Engineering student was to sign up for its mentor program. Not only did his mentor help him land a job he considers a “perfect fit,” he has personally grown, learned life lessons, and built a friendship that he believes will last a lifetime.

“The beauty of this program is that it allows you to build a relationship with someone who will help you get through school, the tough times, and help you see it’s all going to be all right when you graduate,” said Perera.

For Jim Andrews (ChemE ’84), Perera’s mentor, the program has impacted him in ways he never imagined.

“It’s fulfilling to know I’ve been able to have an influence on a young man just starting out in life,” he said.

Each fall, the CSE Mentor Program matches more than 200 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 world of work, and to get advice about what it takes to become successful young professionals.

Making a connection

Andrews acknowledges the time he spent as a chemical engineering student during the early 1980s was “very tough.” Classes were challenging and professors maintained high expectations and standards.

“Stephan experienced the same challenges in his quest to become a University of Minnesota chemical engineer as I did. Only another U of M chemical engineering alumus can understand what it takes to earn this degree. I am sure this is common for all degrees offered by the College of Science and Engineering,” Andrews said.

“My degree taught me more than the principles of chemical engineering. It taught me how to think, to problem solve, to trust my instincts, and to never give up. These are the tools I needed to start my own company,” he said.

In 1988, Andrews founded ADO Products, a manufacturer and distributor of building products based in Rogers, Minn. “My family and I owe a lot to the University. The education we received allowed us to provide a comfortable living for our families,” he said.

To show his gratitude, Andrews financially supports CSE with an endowed scholarship, and is planning to endow a chair in a deferred gift. Yet, he never felt truly connected to the University until he became a mentor.

After Kim Dockter, CSE’s director of external relations, suggested he might feel more engaged if he worked directly with students, he applied to the program.

Building a relationship

By fall, Andrews was matched up with Perera, an international student from Sri Lanka who grew up in Dubai. The only thing they had in common was chemical engineering at that point.

“I mentored Stephan in the same way my father mentored me,” said Andrews. “Listening to his concerns, understanding what he was going through, and giving advice like, ‘you need to sleep more, you need to eat, you need to make sure you get some exercise, and stop worrying about your GPA,’ seems like simple advice, but it was support he needed.”

Perera says Andrews was not only a surrogate father to him, but someone who helped him reach critical milestones as a student.

“Because of Jim’s connection with professor Chris Macosko (he had done research in his lab when he was a student), I was able to do research in his...
lab, beginning as a sophomore, which was almost unheard of,” Perera said.

Perera also credits Andrews with helping him find an internship, and land permanent employment.

“It’s way tougher to find an internship as an international student, because of visa and work restrictions,” Perera said. “With Jim’s help and connections, I was able to intern at a fiberglass facility in Michigan for two summers.”

Moving on to the real world
Perera graduated this past spring. In June, he was hired as a process engineer at CertainTeed, a fiberglass manufacturer with a plant located in Chowchilla, Calif. The company is part of Saint-Gobain, a 360-year old conglomerate headquartered in France. Andrews’ connections made all the difference.

“I didn’t get the job for Stephan, I just introduced him to them, and he took it from there,” said Andrews “He was an attractive hire because of his world-class education and the fact he speaks five languages.”

“Mentoring works both ways—mentors can mentor, but mentees have to want to be mentored. Jim was willing to invest the time and effort. His smallest piece of advice would have the biggest impact, and you can’t pay money to buy that. It comes from experience,” Perera said.

Even though his mentoring duties with Perera are officially over, Andrews knows they will remain friends and professional allies.

“This has been a great ride. It has changed my life, and I will definitely continue to build new relationships through the mentor program,” he said.

Watch for information about participating in the 2016-17 CSE Mentor Program. If you have questions, please contact Joelle Larson in CSE Alumni Relations at: jblarson@umn.edu or 612-626-1802.
Before smartphones and laptops, no serious science or engineering student would be caught on the University of Minnesota campus without a slide rule. During the 1950s and 1960s, the remarkable instrument—small, light, efficient, and not requiring batteries—would most often be carried in a belt holster ready for calculating action.

Also known as a slipstick, the slide rule itself is a kind of computer—the very basic, very analog kind. Often no larger than a 12-inch ruler and marked with numbers, the powerful mechanical computing device operates by sliding in and out to show relationships between different sets of numbers.

Developed in the 17th Century by Reverend William Oughtred, an English mathematician and Anglican minister, and others, the slide rule is based on the work of John Napier, a Scottish mathematician, physicist, and astronomer, who discovered the concept of logarithms.

The slide rule was universally used for nearly 400 years and was the most commonly used calculation tool in science and engineering. Perhaps its most impressive use was during the Apollo 13 crisis when engineers had to recalculate data to guide the crew safely back to Earth—and they had to do it quickly all with the aid of a slide rule.

Yes, the slide rule was a powerful tool until the early 1970s, when things began to change.

On February 1, 1972, Hewlett-Packard introduced the HP-35, regarded as the first successful scientific pocket calculator. It sold for about $395. It was the first handheld calculator ever to perform logarithmic and trigonometric functions with one keystroke. In effect it was the world’s first electronic slide rule.

Seemingly overnight, the trusted, reliable, and handsomely crafted slide rules in the pockets of their owners were rendered obsolete.

Many slide rules went into the trash and were replaced by the new technology. Some were packed away in storage boxes or drawers to be revisited when their owners felt nostalgic. Still others ended up on display shelves as a reminder of a bygone era.

Yet, despite the calculating power now held in today’s smartphone or scientific calculator, the slide rule isn’t quite dead. It’s a remarkable precision instrument that holds fond memories and a special place in the hearts of many College of Science and Engineering alumni. Read some of their recollections.
It was always a rule to never fasten your slide rule to your belt unless you wanted to be considered what is today called a “nerd.” No backpacks—just books, notebooks, etc.—with the slide rule on top.

If you dropped your slide rule on the end, it had to be whacked a little to get it back in adjustment. Since a slide rule knows no decimal places, the approximation always had to be carried in the head. Some may not agree, but for me, it gave me a wonderful ability to approximate numbers for years to come.

With a little practice it was always accurate enough to accomplish the results. Pleading a slide rule error usually did not work.

—Gordon Lewis (ME ’51)

I still have my K&E Deci-Lon slide rule. It cost me $25 in 1962 when tuition was only $91 per quarter. My recollection of one of the problems with slide rules was that you had to keep track of the decimal place in your head. The small HP 35, which arrived in the early 1970s, was the best thing since sliced bread. It had reverse Polish notation, which the Texas Instrument calculators did not have. The big problem was the first HP unit cost about $400—a fortune in those days. It was like moving from the horse to the car when we moved from slide rulers to calculators.

—Henry Hanson (ME ’66)

We were still using the slide rule when I was in college. In about 1972, when HP came out with their calculator, several students switched from the slide rule to the calculator. I thought the slide rule was the best thing since sliced bread. I purchased my K&E slide rule from a friend who had graduated in mechanical engineering and no longer had a need for it. It was one of the more expensive models made of wood. Every once in a while, it would become hard to slide. One of my fellow students said that the best lubricant was the oil from the pores on his face. Guess what? It worked! Of course, you had to clean the surface of your slide rule and your hands after this. As students, we could be creative, efficient, and save money when necessary. Also, the engineering bookstore had a policy that if we brought in our slide rule and it needed replacement screws, they would provide and replace them. Those were the good old days!

—H. Richard (Dick) Coleman (CivE ’73)

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Slide rule is alumnus’ treasured memento

When Erwin Kelen (EE M.S. ’60) left Hungary in 1956, during the aftermath of the Hungarian Revolution, a nationwide revolt against the government of the Hungarian People’s Republic and its Soviet-imposed policies, one of the few material things he carried with him was his trusted German-made pocket slide rule.

“It was a 14-centimeter Faber-Castell, a real beauty. I still have it today,” said Kelen. “I have not used it in decades, but it is a treasured memento.”

While others used a foot-long “engineering” slide rule, Kelen, who came to the University of Minnesota in the late 1950s for graduate school, said he always preferred this smaller plastic version safely ensconced in its handsome green leather case.

During his time in graduate school, Kelen served as a teaching assistant and decided he would have a little slide rule fun with his class.

“I was at the blackboard in front of my class, solving a problem, and I was reading the results off my slide rule. Four decimals first, then squinting, two more,” he said. “Imagine, six digit accuracy from a pocket slide rule!”

After class, all the students crowded around him, wanting to know how he could read this from a tool that basically had two decimal capability. At first he was coy in telling them that it was a special secret that enabled him to calculate with such accuracy. Surprised, they insisted he tell them his secret.

“I ‘fessed up that the last four decimals of the six were purely invention on my part and we all had a good laugh,” Kelen said.
WHAT DRIVES TIM LAPARA TO TREAT SEWAGE AS A NOVEL SOLUTION TO ANTIBIOTIC RESISTANCE?

It's one of the most pressing threats within modern medicine: the rise of antibiotic resistance. But the current scientific paradigm—to restrict antibiotic prescriptions and curtail antibiotic use in agriculture—doesn't fully address the problem, says professor Tim LaPara. "Getting rid of antibiotic resistant genetic material at the wastewater treatment level is a new way of thinking," he said. LaPara is proposing a systemic upgrade of our wastewater treatment facilities that would destroy the genes used by the antibiotic resistant bacteria in our sewage. That paradigm shift may be the key to keeping humanity healthy.

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