On the Crest of Waves Research

BOJAN GUZINA: WAVE-BASED SENSING

JOSEPH LABUZ: LISTENING TO ROCK

STEFANO GONELLA: WAVE CONTROL WITH SMART MATERIALS
Dear Colleagues, Alumni, and Friends,

In the academic calendar, fall always feels like a new beginning. That feeling is even stronger this fall as we begin with a new strategic plan. Our vision and mission have been captured by faculty working with graphic artist Nick Neary in some beautiful banners that now hang in our rotunda. I look forward to showing them off next time you are on campus.

The real substance of our mission does not hang on walls, however. In this issue of CEGE magazine, you will read about work our faculty, students, alumni, and industrial partners have been doing to embody that mission. A few highlights include alumnus Bernie Bullert’s efforts to establish a water research center; a look at the research contributions of Professors Bojan Guzina, Stefano Gonella, and me; and new leadership in the College with Dean Sam Mukasa. You will also read about one of our impressive students, Robert Rudin III, who balances his classes with his demanding role as Drum Major for the Marching Band.

I am looking forward to this academic year with a renewed sense of purpose and hope for the accomplishments of our team. Thank you for your continued support and involvement. I hope to see many of you on October 22 at our homecoming breakfast and open house.

Go Gophers!

Joseph Labuz

MSES/Miles Kersten Professor & Head
Department of Civil, Environmental, and Geo-Engineering
CEGE is supported by a heavy-hitting advisory board, drawn from our local industrial partners and the professional engineering community. We really could not do what we do without them!

Our board is composed of 15 members, all graduates of the CEGE department and experts in their fields. These individuals advise departmental leadership on issues ranging from educational programs to employment, from internal activities to outreach, and even scholarships for CEGE students.

Board members are asked to focus on four broad purposes. They work to promote the department locally and nationally. They advise the Department Head with regard to academic and strategic issues, communicating the needs of the engineering community, and commenting on the future direction of the industry. They evaluate program objectives and interact with students, providing employment opportunities and acting as mentors. They provide philanthropic support and assistance in seeking financial gifts to help the department achieve its academic mission. Members serve for three academic years; retired members who wish to stay active serve as Ambassadors.

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UNIVERSITY PRESIDENT ERIC KALER (center) and new CSE dean SAMUEL MUKASA (right) toured the Civil Engineering Building and met with faculty (LAUREN LINDERMAN, left) and students early in the fall semester.

GLENN SCHREINER (BCE 1978, chair of CEGE Advisory Board) has been honored with the ACEC Tom Roche Lifetime Achievement Award. Schreiner, of WSP Parsons Brinckerhoff, has an engineering career spanning almost 40 years. He has been a committed participant with ACEC and has served in a number of capacities, including President and National Director of the ACEC/MN Board of Directors.

Professor Emeritus HEINZ STEFAN has been named as an American Society of Civil Engineering (ASCE) Distinguished Member, honoring his pioneering work linking environmental considerations and hydraulics. His expertise in the design of cooling water intake and discharge facilities led to advisory roles for the electric power industry domestically, as well as in Brazil, China, and India. The title of Distinguished Member is the highest honor bestowed by ASCE. Fewer than 700 people have received this honor in the entire history of ASCE.

DEPARTMENT

Minnesota senators visit: SENATOR AL FRANKEN (pictured, center) visited in August to learn about research done at the St. Anthony Falls Laboratory; SENATOR AMY KLOBUCHAR was here in May to view the Center for Transportation Studies' research on distracted driving.

We are pleased to announce two new scholarships: The Minnesota Geotechnical Society endowed a new scholarship to support graduate and undergraduate students, and Barr Engineering created the Doug Barr Student Research Scholarship in honor of their founder Doug Barr and in celebration of the company’s 50th anniversary.

Homecoming 2016: Golden Gopher Glory! October 22. Join us for a CEGE Homecoming Celebration—breakfast and open house before the football game, 9-11 a.m. in the Civil Engineering Building. A reserved a block of tickets to the Gophers vs. Rutgers game are available. Details on our web page.

FACULTY

BOJAN GUZINA received $345,000 from the National Science Foundation to study “3D Imaging and Characterization of Fractures in Rock.”

JOHN GULLIVER has four ongoing research projects totaling 1.4 million dollars: “Stormwater Research Priorities and Pond Maintenance” funded by the Minnesota Pollution Control Agency; “Permeable Pavement for Road Salt Reduction,” the Local Road Research Board; “Iron-Enhanced Swale Ditch Checks for Phosphorus Removal,” Minnesota Department of Transportation and Local Road
Research Board; and “Understanding Impacts of Salt Usage on Minnesota Lakes, Rivers, and Groundwater,” Legislative and Citizens Commission on Minnesota Resources. You can see several other recently funded projects led by CEGE faculty at cege.umn.edu, under Research, Research Areas.

SEBASTIAN BEHRENS authored an article in Scientific Reports (June 2016) on an environmental survey that provides new insights into processes that form and degrade halogenated organic compounds. He led an international team of researchers who sifted through the complete genomic inventory of a pristine forest soil to uncover the diversity, abundance, and distribution of genes encoding for halogenating and dehalogenating enzymes. The results have implications for the use of halogens as a tracer of soil-water, represent a step toward increased understanding of natural sources and sinks of organohalogen compounds, and raise questions about the importance of natural microbial halogen cycling for atmospheric chemistry, earth climate, and bioremediation.

Three traffic researchers were featured in the CSE publication Inventing Tomorrow (Winter 2016). Experts JOHN HOURDOS, DAVID LEVINSON, and CHEN-FU LIAO describe their efforts to improve our transportation networks—from monitoring our busiest roadways to apps for blind pedestrians to imagining a world without traffic. John Hourdos, Director of the Minnesota Traffic Observatory, was also quoted in Traffic Technology Today, explaining the establishment of a testbed on I-94 for developing and testing connected vehicle technologies and applications, including speed harmonization and queue warning, as part of a project funded by the Roadway Safety Institute.

MIKI HONDZO is leading research using new, advanced water quality monitoring equipment in Madison Lake, Minnesota, to track the weather, environmental conditions, and lake processes that produce, sustain, or prevent harmful algal blooms. The research will bring researchers one step closer to algal bloom prediction and prevention.

Two CEGE professors awarded chairs. GARY DAVIS has been named the Richard P. Braun/CTS Chair in Transportation Engineering. PAIGE NOVAK has been named the Joseph T. and Rose S. Ling Chair in Environmental Engineering. Each professor will hold the named chair through June 30, 2021.

RAYMOND HOZALSKI serves on the United States Environmental Protection Agency Science Advisory Board’s Drinking Water Committee. Hozalski was selected for his expertise in environmental and chemical engineering, and biological treatment processes for drinking water.

TIM LAPARA was among several presenters at the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria on Wednesday, June 21, 2016. A recording of the meeting is available at www.hhs.gov.

Transportation on Tap is a happy hour event in Minneapolis that gets people together to talk about current transportation issues. In July, panelists Leili Fatehi, John Levin, and DAVID LEVINSON, and a lively crowd discussed changes coming with driverless vehicles. The biggest take-away was that autonomous vehicles are coming fast—and regional planning is not keeping up.

PAIGE J. NOVAK has been approved as a Water Environment Federation (WEF) Fellow. The WEF Fellows Program recognizes the professional achievement, stature and contributions of WEF members to the preservation and enhancement of the global water environment. A WEF Fellow must demonstrate ten years of professional experience; five years of active membership in WEF; professional achievement, stature, and contributions to preserving and enhancing the global water environment; contributions to the profession through participation in professional organizations and community involvement; and must have the recommendation of fellow WEF members.

VAUGHAN VOLLER recently visited University of Montenegro (University of Montenegro) where he shared his expertise on graduate engineering programs. Montenegro is interested in providing masters and doctoral studies that are sustainable and of high quality. Igor Vušanović, Dean of Faculty of Mechanical Engineering University of Montenegro, invited Voller, a renowned...
scientist and director of graduate studies of CEGE’s highly-rated master’s and doctoral degrees.

**EMERITI**

**ROGER ARNDT** was honored at the 90th Anniversary of the ASME Fluids Engineering Division with a specially designed medal and certificate for his contributions to the science and practice of fluids engineering.

**THEODORE GALAMBOS** received the Lynn S. Beedle Distinguished Civil and Environmental Engineering Award from his alma mater, Lehigh University. The award, named after Lynn S. Beedle, is given to a graduate or faculty member for outstanding achievements in civil and environmental engineering. The honor was last awarded nearly a decade ago. Galambos was honored in April as part of Lehigh’s 150 year celebration.

**MIKE SEMMENS** traveled to Padua, Italy, in March 2016 to teach and assist in water related research at the University of Padova. Semmens taught in this international program in 2013 and returned this year to teach a graduate class on Water Supply and Treatment in the Department of Civil and Environmental Engineering. He returned to Minnesota at the end of August.

**ALUMNI**

**OTTO G. BONESTROO,** a great friend of the Department of Civil, Environmental, and Geo- Engineering, has died. Bonestroo received both a bachelor’s (1949) and a master’s degree (1950) in civil engineering from the University of Minnesota. He was one of the founders of Bonestroo, Rosene, Anderlik & Associates, Inc., a highly respected engineering firm in the region as well as the second largest firm of its kind in Minnesota. He served on the Minnesota Governor’s Advisory Committee on suburban problems and on the Minneapolis-St. Paul Area Metropolitan Planning Commission. Bonestroo was a strong supporter of CEGE throughout his lifetime. He endowed scholarships, fellowships, and a faculty award; he also endowed scholarships for high school students. He was a member of the American Council of Engineering Companies of Minnesota, the American Society of Civil Engineers, and the College of Science and Engineering’s Alumni Society. In 2007, Bonestroo was honored with the University’s Outstanding Achievement Award. We are thankful for his work. His spirit and memory will live on through all he has done for engineering and to prepare engineers of the future.

**CHANLAN CHUN** (Ph.D. 2006) is a civil engineering professor at the University of Minnesota Duluth. She has a joint appointment to lead a new geomicrobiology program at UMD’s National Resources Research Institute (NRRI), which is partially funded by the University’s MnDRIVE program. This position, which Chun started in 2015, allows her to interact with students and apply scientific findings to solve real world problems.

**MICHAEL F. DONNINO,** (BCE 1976, pictured right) Senior Vice President and Large Projects Division Manager of Granite Construction Inc., received the 2016 Supervision Award from Beavers, Inc. & Beavers Charitable Trust a heavy engineering construction association that recognizes individuals for career achievements in the heavy construction industry.

Four Ph.D. students in the area of geomechanics have recently been hired as assistant professors in departments of civil and environmental engineering at prestigious research universities: **EGOR DONTSOV** (Ph.D. 2012) at the University of Houston, **JAMES HAMBLETON** (BCE 2005, MS 2006, Ph.D. 2010) at Northwestern University, **FATEMEH POURAHMADIAN** (Ph.D. 2016) at the University of Colorado, Boulder, and **ROMAN MAKHNENKO** (Ph.D. 2013) at the University of Illinois, Urbana-Champaign.

Another graduate **ALI EBRHAIMIAN** (Ph.D. 2015, advised by John Gulliver) has taken a position as a Post-Doctoral Associate at the Villanova Center for the Advancement of Sustainability in Engineering, Villanova University. You can read about his research in last fall’s issue of CEGE magazine (Fall 2015).

Read more news from CEGE online at [www.cege.umn.edu](http://www.cege.umn.edu) or follow us on Facebook ([facebook.com/umn.cege](http://facebook.com/umn.cege)).
TONY KAPPELL, P.E. (BCE 2001, MS 2003), has been named an Associate at McMAHON, a Midwest engineering and architectural firm. Kappell has 13 years of experience in planning, design, and project management of wastewater treatment, biosolids management, and water supply, treatment and distribution projects. His experience spans municipal, industrial, and private sector applications.

THOMAS LAMB, PE, LEED (BCE 1980) was recently hired by American Engineering Testing, Inc., as a principal engineer and engineering manager in the company’s regional Duluth office. Lamb will be responsible for providing senior geotechnical and materials engineering services and project management. He has worked in multiple areas of consulting including geotechnical engineering, concrete testing, building forensics, owner representative services, environmental consulting and building condition assessments.

JOHN F. ORSBORN (MS 1960) died at his home in Port Ludlow, Washington, on January 21, 2016. Orsborn was a faculty member in the Department of Civil and Environmental Engineering at Washington State University from 1964-1991. In the course of his career, Orsborn received many honors including Engineer of Merit (inland Empire Section of ASCE) and ASCE Fellow.

JOHN SACHI (BCE 1982) retired in July after 25 years as the City Engineer and Public Works Director for City of South St. Paul. UMN alumni stood out at the annual meeting of American Council of Engineering Companies of Minnesota in May. PAT MCGRAW (BCE 1997), a past president of Stantec, was honored by ACEC for his leadership over the past year. Incoming President Dan Murphy of Meyer Borgman Johnson presented McGraw with an honorary gavel in recognition of his service to the association. JAKE TURGEON, PE (BCE 2009; pictured, right), who works at HGA Architects and Engineers, won the Emerging Leader Award from the American Council of Engineering Companies (ACEC) of Minnesota.

JONATHAN WACKER, PE (BCE 2004) is now the Associate Vice President of HGA Architects and Engineers and was honored with the ACEC Distinguished Service Award.

MARK WINSON (BCE 1978) is the Special Projects Manager for the City of Las Cruces, New Mexico, a city of over 100,000 people. Winson also has a master’s degree in strategic leadership from Mountain State University in Beckley, West Virginia. He previously worked in Fort Collins, Colorado, and Duluth, Minnesota.

STUDENTS

KAYLEA BRASE, a master’s student, was awarded a Walter H. Judd International Graduate & Professional Fellowship from the Global Programs and Strategy Alliance in the amount of $2,500 to support her research project in India. In addition, Kaylea Brase and CHRISTOPHER BULKLEY-LOGSTON won the graduate division of the EIX student Venture Competition, an additional $10k toward their pilot project.

Two SAFL/CEGE students received Outstanding Student Paper Awards from the American Geophysical Union 2015 Fall Meeting: JON CZUBA wrote “Near-channel sediment sources now dominate in many agricultural landscapes: The emergence of river-network models to guide watershed management.” ZEINAB TAKBIRI was recognized for his work on “Microwave Signatures of Inundation Area.”

EMILY ERHART received a WAAIME scholarship through the Society for Mining, Metallurgy & Exploration. The WAAIME Scholarship fund provides scholarships to students pursuing earth science degrees including mining, geological sciences, metallurgy, petroleum, mineral sciences, materials science and engineering, mineral economics, chemical engineering and other related studies.

A team of three students won the Institute of Transportation Engineers (ITE) Midwest Region Traffic Bowl competition in June. Traffic Bowl is a jeopardy style game with questions on transportation standards and practices—and these student members of UMN’s Interdisciplinary Transportation Student Organization (ITSO) know traffic! BENJAMIN NAULT-MAURER, ELLIE (MEEKYUNG) LEE, and JACKIE NOWAK competed under the guidance of ITSO member Miguel Andrews against 5 other schools and secured first place. The team earned a $1,000 check and travelled to California for the ITE International Conference.
ARDESHIR EBTEHAJ joined the CEGE faculty this fall. He is actually returning to UMN where he completed both an MS in Mathematics and a Ph.D. in Civil Engineering (2013). He had completed a BS and an MS (in Civil Engineering) at the Iran University of Science and Technology before coming to graduate school in the United States.

As a student, Ebtehaj received the 2011 Interdisciplinary Doctoral Dissertation Fellowship between the Department of Civil, Environmental, and Geo- Engineering and the Minnesota Center for Industrial Mathematics. He also served as a NASA Earth and Space Science Fellow. After graduating, Ebtehaj worked two years as a postdoctoral researcher at Georgia Institute of Technology, and in 2015 he joined the Department of Civil and Environmental Engineering at Utah State University as an assistant professor.

His research experience includes hydrologic remote sensing and inverse problems in hydro-meteorological systems, physical hydrology and land-atmosphere interactions, stochastic hydro-meteorology, and environmental risk and extreme value analysis. The overarching goal of his research is to increase our understanding of the global water-energy cycle and of land-atmosphere interactions for improving water, food, and energy security.

“I am very excited to join such a fantastic community of scholars and students at UMN—the place where I grew up scientifically and the place that has shaped my research character. The Department of Civil, Environmental, and Geo- Engineering and, in particular, the Saint Anthony Falls Laboratory are among a few leading institutions in the world that are advancing the cutting edge of knowledge in water science and engineering. The accomplished faculty—senior members and new hires—are going to launch a new era in knowledge production and educational training in the areas of water, environment, and earth system sciences. I am humbled and honored to become a part of such an extraordinary team and to build on that tradition of great educational leadership.”

RENA WEIS, an environmental engineering student, traveled to Asheville, North Carolina, to present at the National Conference for Undergraduate Research. “The experience was everything I hoped it would be. I presented to students and faculty from across the country. It was an honor to be one of the nine students representing UMN. I hope that CEGE students can continue to represent the University at the conference in the future.”

The University of Minnesota CONCRETE CANOE TEAM finished in fourth place overall at the Midwest Regional Concrete Canoe competition in Ames, Iowa, in April. The team took third place in the design paper and final product/aesthetic portions of the competition and second in the presentation portion. Although their canoe broke in half during the second race of the day, they still managed to come away with a fourth place finish overall out of nine teams!

Two summer programs helped introduce young students to engineering. The National Summer Transportation Institute for students in grades 7-9, and the YMCA Girls, Inc., Eureka! Program for girls in grades 8-12. See what the future of engineering looks like in our Facebook photos.
BERNIE BULLERT STRONGLY BELIEVES THAT WATER RESEARCH HAS AN ESSENTIAL ROLE TO PLAY IN THE FUTURE OF OUR CITIES, STATES, AND NATION.

Water quality is in the news a lot lately. It seems to be in everyone’s best interest to preserve water quality, but the problems seem big, complex, and confusing. Management of our precious water resources must encompass the quality of our streams and lakes, the cleanliness of our water supply, the treatment of wastewater, the management of storm water, and the infrastructure necessary to make all those pieces work together. What can be done?

One man—who understands more than most of us about what it takes to sustain a clean water supply—has an idea to effect wide-ranging, long-term solutions. Bernie Bullert has a vision to start a water research center at the University of Minnesota.

Why Research? Why Minnesota?

Bullert has long had a penchant for research. Early in his career he saw the benefits that come from scientific study and careful application of results. So Bullert is proud of the work he did to initiate research programs during his time as a leader in the water utility departments of both St. Paul and Minneapolis. The Metropolitan Council also began sponsoring research, partly due to Bullert’s influence.
After a long and successful career devoted to making sure the cities have safe drinking water, Bullert might be expected to retire and use his free time to pursue his interests in cars, Corgi show dogs, public art, or travel. But this crusader is not yet satisfied.

“That still leaves the rest of the state of Minnesota!” says Bullert, “Outside the Twin Cities, communities still face water problems that need solutions. In rural Minnesota, communities are smaller and don’t have the money or the set-up for research, yet small towns need solutions, too.”

Bullert is convinced of the importance of research that continuously pulls Minnesota and water resource management forward: “Water is a fluid business. We cannot allow our knowledge, technologies, or management practices to become stagnant. One way to help ensure that Minnesota and all Minnesota’s citizens benefit from our latest knowledge of water resource management, is to establish a statewide center for water research.”

Minnesota is doing great research in the areas related to water resources. Bullert wants to build on that foundation and to ensure that needs of outstate Minnesota are met. He also sees that Minnesota could contribute some unique knowledge based on our northern, water-rich location.

Through his work, Bullert is recognized as a thoughtful and respected leader in the water/wastewater industry. He spent most of his career in the public sector. Bullert worked for Saint Paul Regional Water Services for 35 years. That system serves over 400,000 people. For twelve of those years Bullert was the General Manager of the utility, with a budget at that time of about $40 million. In 2003, Bullert stepped into the private sector, performing water system engineering work for TKDA, an engineering, architectural, and planning firm based in Saint Paul, Minnesota. He transitioned back to the public side in 2009, taking on his role as Director of Water Treatment and Distribution Services for the City of Minneapolis, where he served until 2013. During his tenure in Minneapolis, Bullert managed an annual budget of $75 million, improved the quality of drinking water, strengthened the effectiveness of the organization, and reduced water losses within the system. He returned to TKDA where he served for several years as Group Manager of the Water/ Wastewater Division. Today, he continues to work as a consultant with TKDA, in addition to his other activities.

Bullert has been an active member in several water-related organizations. The Minnesota Chapter of the American Public Works Association (APWA-MN) honored Bullert with the 2011 Director of the Year Award, recognizing his leadership and ability to effectively manage the Minneapolis water system. Bullert served on the American Water Works Association (AWWA) Standards Council, the Water Utility Council, and the Manufacturer’s Associates Council. He is a past Director of the AWWA and has received several awards including the Fuller Award, Leonard Thompson Award, and in 2014, AWWA’s Honorary Member Award for his passion to improve water quality and access to potable water worldwide. In 2001, Bullert received the Association of Metropolitan Water Agencies’ (AMWA) President’s Award for his service as AMWA’s representative on the EPA’s Children’s Health Protection Advisory Committee.

His experience, both as a professional and as a volunteer, is one indication of the breadth of his knowledge and passion for sustainable water systems. Bullert attributes his success to his love of and commitment to clean water. “It’s good to enjoy what you do. When you enjoy what you do, you’ll be successful,” says Bullert.

To accomplish his latest vision, Bullert has “enjoyed” himself a lot—enjoyed meaning he has done a lot of work! He has been making connections and promoting his idea among industry and political leaders, state legislators, water industry leaders, and researchers at the University of Minnesota.

Bullert indicated his commitment to this cause by establishing the Minnesota Water Research Fund at the University of Minnesota. While a state-based research center will require much more than his individual contribution, Bullert believes the fund will be a catalyst. By leading the way, he hopes to stimulate discussion about water resources and motivate others to get involved and contribute to making a Minnesota water research center a reality.

The Vision

The proposed water research center would work to preserve and improve water quality by promoting sustainable water management and treatment. The center would perform research aimed at solving current and emerging water quality problems; would train engineers and scientists to work in water management and treatment industries, thus building the State’s technical capacity; and would educate water industry professionals and the general public about water issues. Changing people’s habits and behavior can be a huge challenge. “People need information and motivation to make changes that may not have an immediate or personal impact. It is difficult but important,” says Bullert, “to adjust our priorities and move toward long-term thinking about our water resources.”
The proposed center could also cultivate industry partners to collaborate on development of water technologies, which could stimulate economic development.

A Minnesota-based water research center could capitalize on the state’s northern location to address some unique issues affecting cold-water treatment systems. For instance, when lakes and rivers become ice-covered in the winter, oxygen in the water is depleted and water quality can change. Frozen ground hinders infiltration of rainwater and snowmelt into the ground. Cold water has an increased viscosity that adversely affects treatment processes such as filtration and sedimentation. Seasonal changes vary the concentration of natural organic matter in water, and that impacts drinking water treatment. Biokinetic rates can be significantly decreased in cold water resulting in less efficient wastewater treatment. Deicing salts used for roads run into the rivers and lakes and increase chloride levels in the water coming into the treatment plants. All these issues affect water treatment systems, and Minnesota provides a natural setting in which to study these issues. Research on these issues could significantly affect water quality—not only of cold-weather cities and watersheds, but also of communities and lakes downstream along the Mississippi.

The proposed center could help guide critical water infrastructure decisions and investments throughout the state, particularly in those small communities where funds for research, training, and education are scarce.

These big ideas are grounded in applicable research with the goal of offering practical solutions for watersheds throughout Minnesota and beyond.

Bullert is working hard to enlist partners and visionaries to make this dream a reality for Minnesota. “We have some start-up funding, and we are looking at models for permanent funding, trying to determine which could work best for this situation.”

“Everyone needs clean water to survive,” says Bullert. “We need to convince today’s decision makers how critical our water infrastructure is to keeping our society successful.”

The envisioned center would establish a commitment to long-term, ongoing water research. Acting on our best knowledge of water resources should enhance our state’s outlook for economic robustness and the health of Minnesota’s citizens, now and in future generations.

Are you ready to take action that will help Minnesota preserve our water resources?

If you are interested in contributing to the Minnesota Water Research Fund, contact Shannon Wolkerstorfer, External Relations, at 612-625-6035 or swolkers@umn.edu.
VISION AND MISSION BANNERS

Faculty worked with graphic artist Nick Neary to capture the vision and mission of CEGE. These beautiful banners now hang in our rotunda.

CEGE’s vision of inspired and innovative engineering for society is shaped by teaching, research, and service, and these are captured in the themes learn, discover, transform.
Learn highlights student experiences in the classroom, laboratory, and office. Discover exemplifies cutting edge research. Transform showcases work that impacts many facets of theory and practice.

See the full strategic plan on our website. Request a printed copy by sending your name and address to cegenews@umn.edu.
The study of acoustic and elastic waves is one of the pillars of modern engineering mechanics. Recent technological advances have turbocharged various new developments in this rich field and opened exciting possibilities for engineering breakthroughs and new collaborations with the physical sciences.

CEGE houses a unique nexus of expertise in waves. CEGE faculty members pursue several avenues of waves research, the tentacles of which reach into wide-ranging areas including subsurface monitoring, web-based sensing, medical imaging, non-destructive testing, innovative materials design, seismic control, and more.

The work of three CEGE researchers illustrates the breadth of waves research being done in CEGE and how these research approaches and results are addressing some of today’s toughest enduring and emerging engineering challenges.

**BOJAN GUZINA: WAVE-BASED SENSING**

“WAVES AND VIBRATIONS ARE UBIQUITOUS. WITH PROPER UNDERSTANDING WE CAN USE THEM, WITH VIRTUALLY NO ADVERSE EFFECTS, TO ‘SEE THROUGH’ AND INTERROGATE BODIES AS LARGE AS OUR PLANET OR AS SMALL AS TINY LESIONS IN OUR BODY.”

Guzina’s research goal is to develop innovative ways in which waves can be used to non-invasively probe, image, and diagnose earth’s subsurface, civil infrastructure, engineered materials, and even human bodies.

Guzina’s research addresses issues at the interface of engineering and applied mathematics. His engineering expertise gives him insight into physical processes and mechanics that make things work. He also understands mathematical theories and computational tools that can make engineering tasks easier. His multidisciplinary knowledge helps him see new pathways for progress, leading to new theories and new solutions.

Vibration and waves have long been lynchpins of remote sensing. Waveform sensing capabilities have greatly expanded over the past decade, due in part to breakthroughs in wireless communication, signal processing, and design of microelectromechanical systems. These technological advances, however, have yet to provide real-time 3D “scans” of solid bodies, which could be used to maintain dams or nuclear power plants, or to ensure safe mining operations and efficient energy production (e.g., hydraulic fracturing).

To help bridge the gap, Guzina’s research group is developing new theories and techniques to make 3D imaging and diagnosis of solids and structures by way of waveform tomography (which normally requires the use of supercomputers) possible for everyday engineering applications. See examples in Figure 1.

Materials including rock, concrete, or human tissue, are rarely homogeneous as presumed by classical theories of wave-based sensing. Instead, they contain small features (mineral grains, aggregate, vasculature) that cumulatively affect the propagation of waves through the matter. One impact is that “short” (seismic or ultrasonic) waves repeatedly bounce off small-scale heterogeneities, thus restricting wave-based interrogation of real materials to “long” (low frequency) waves. Unfortunately, the use of only long waves as an imaging tool is limiting because the resulting tomographic images are coarsely pixelated.

Guzina strives to propel the use of sub-wavelength imaging by looking at long-wavelength data and identifying the “fingerprints” of sustained, small-scale heterogeneities inside a material.

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Figure 1. 3D seismic reconstruction of an S-shaped tunnel (left) and cylindrical fracture (right) by non-iterative waveform tomography.
JOSEPH LABUZ: LISTENING TO ROCK

“We can think about wave disturbances at various scales. The very large scale is an earthquake, and we often see its destructive effects. In my lab, however, we study very small disturbances—microcracks—that are millimeters in size and last only milliseconds in time.”

The goal of Labuz’s research is to use waves called acoustic emission (AE) to study how brittle solids (rock, concrete, etc.) fail or break. This understanding is useful in designing more economical ways to break rock and in protecting workers in underground mines.

Labuz and his students focus their research on three main areas: Developing and testing theoretical models related to quantitative analysis of AE data, in particular calibrating transducers and modeling crack sources; Conducting experiments to verify AE results through complementary observations of fracture initiation and propagation; and applying AE to monitor the failure process of structures composed of brittle solids under various loading conditions, from tensile fracture to shear localization.

Rock and concrete may appear solid, but microscopic observations have shown that small cracks are naturally present in these brittle materials. When mechanical or thermal loads of sufficient magnitude are applied, the small cracks can grow, releasing some energy as elastic waves. The emitted waves, AE, can be detected by piezoelectric transducers attached to the surface of the material. “Listening”...

STEFANO GONELLA: WAVE CONTROL WITH SMART MATERIALS

“My students and I investigate strategies to control waves in media characterized by complex internal architectures. The technological goal is to design materials with desired and tailored dynamic functionalities. Our ultimate objective is to be able to mold intangible and invisible elastic wavefields with the same level of freedom and flexibility that we normally observe in the manipulation of physical matter.”

Recent years have seen a breadth of new ideas and concepts pertaining to wave control and manipulation due in part to the advent of a new class of materials called mechanical or elastic metamaterials. Metamaterials are structural materials that owe their unique behavior to their complex and unconventional internal structures rather than to their (chemical) compositions. Because of the unconventional way in which their internal structural components (beams, rods, shells, etc.) are arranged and connected geometrically, metamaterials behave in ways that are vastly superior to what could be achieved by their individual components taken as stand-alone elements.

The most exotic properties of metamaterials are observed in the realm of wave propagation. “We can control the way elastic waves propagate in metamaterials,” Gonella says. “For example, we can design materials that block certain wave frequencies while allowing others, thus behaving as mechanical filters or wave-
BOJAN GUZINA CONT...

develops theories addressing two fundamental questions: how does microstructure affect the global wave motion? and what can we learn about the microstructure of an anomaly using tomography with long-wavelength illumination? Guzina directs his research toward analysis of media with microstructures that are random, periodic, or fractal (Figure 2); in this way he develops next-generation tools to characterize and diagnose earth’s subsurface, engineered materials, and human tissue in ways that would have been unthinkable only a few years ago.

Human tissue, unlike rock or concrete, are easily deformed and so propagate nonlinear ultrasound waves, even at small amplitudes. This nonlinearity endows ultrasound waves with an ability to help diagnose human tissues in ways other imaging techniques cannot. For instance MRI scans are capable of revealing very small lesions in a human body; however, a biopsy is often required to diagnose a dark spot in an MRI image. Guzina is developing models and theories by which nonlinear, focused ultrasound waves can help a radiologist make a diagnosis without a biopsy by remotely pushing on a lesion via the so-called Acoustic Radiation Force.

Guzina’s research group tests their wave models and imaging theories by propagating ultrasonic waves though rock specimens, engineered materials, and tissue-mimicking phantoms using the 3D Scanning Laser Doppler Vibrometer (SLDV) located in CEGE’s Waves & Imaging Laboratory (Figure 3).

JOSEPH LABUZ CONT...
to these waves can help researchers understand what is going on beneath the surface. AE has proven to be a powerful engineering technique to evaluate the integrity of a structure, such as an underground mine or a concrete bridge, by determining the locations of weak planes or unseen fractures within the structure.

AE has been widely used as a monitoring technique to determine cracking and assess degradation of materials to assure safety of various systems. One of the first observations of acoustic emission, made by the US Bureau of Mines in 1938, was associated with an underground mine. Current applications typically focus on structural health monitoring in industries...

Figure 4. AE detection: material containing a microcrack with transducers attached.

Figure 2. Sub-wavelength sensing: shear wave (wavelength $\lambda \sim 3mm$, middle panel) propagating in a gelatin sample containing polystyrene microspheres (diameter $10\mu m \sim \lambda/300$, left panel). The wave senses the microstructure via dispersion— the dependence of wave speed on frequency (right panel). Joint work with Ralph Sinkus, King’s College, London, and Sverre Holm, University of Oslo.

In general, the theoretical models of AE use principles and techniques similar to those developed by seismologists to study earthquake mechanisms. Obviously, the scales from the lab to the earth’s crust are vastly different. A more important difference, however, is that an earthquake is associated only with a sliding crack. When studying cracks in subsurface and infrastructure applications, the mechanism of crack opening must also be considered.

In addition to using arrival times to determine source locations, AE waveforms (Figure 5) can be analyzed to characterize a crack: the extent of sliding or opening and orientation.

Figure 5. AE waveform

Part of the research has concentrated on modeling an AE event as a small crack that slides and opens (or closes). This theoretical model relates a crack at a known location within the solid to the wave displacements at each transducer, and the transducer output (voltage) must be calibrated to actual displacements. The model can then be used to charac-
terize the crack mode (opening and/or sliding) and orientation.

New methods have been developed by Labuz and his team of researchers that provide a means to determine crack kinematics even though the crack is not visible.

The capabilities of these methods can be demonstrated in the lab by loading a beam instrumented with AE transducers and testing it to failure. AE clearly locates the initiation of a fracture through the clustering of events (Figure 6). The analyses indicate that the small cracks generating the AE were on the order of millimeters in length, similar to the average grain size of the studied material. Further, the analyses show a crack-opening tendency compatible with the failure mechanism of the beam. The AE method allows for non-invasive evaluation of fracture in the subsurface and built infrastructure.

Layer equipped with wave-controlling capabilities that could steer and reroute the energy, preventing it from reaching the interior of the airfoil and causing damage.

Over the past few years, concepts of mechanical metamaterials have been proposed as solutions to problems in infrastructural engineering and earthquake control. Gonella’s group has embraced this challenge and is exploring concepts of seismic shields based on periodic arrays of tunable resonating units. “The application of metamaterials in seismic control is still fairly hypothetical, an idea that has only marginally been tested against realistic field data. Many challenges (such as size constraints, affordability, variability in the frequency signature of seismic events) must be addressed before seismic shields could be implemented. However, all the elements are in place and the potential is huge. We are not talking about a far-fetched idea; this is a powerful technology that is worth serious exploration.”

Gonella is very comfortable and even proud of the speculative nature of his research. “My main contribution is, first and foremost, to generate new ideas and support them with innovative proofs of concept. The process requires convergence of long-term efforts by a large pool of researchers. My research group always keep applications in front of us as guiding stars. However, our signature contribution comes from the bottom up, pushing from the fundamentals.”

**STEFANO GONELLA CONT...**

guides (Figure 7). We can also engineer metamaterial architectures that can steer a wave, forcing it to follow a prescribed path within the material (Figure 8), instead of allowing it to propagate with equal speed in all directions, as is commonly observed in conventional media. This could be called an acoustic shield, capable of deflecting harmful waves away from a sensitive target. With these capabilities, metamaterials could revolutionize how we manage vibration and sound problems.”

It is possible to establish a rigorous mechanistic relationship between the wave propagation phenomena observed at the macroscopic scale and the geometric architecture of these materials. “A big component of our research work is dedicated to developing mathematical models, predictive simulation tools, and laboratory experiments necessary to shed light on this complex relation. Once this link is fully understood, the internal architecture of the material can be engineered at will and we can design materials with a wide range of desired functionalities.”

The applications for metamaterials stretch across a broad range of disciplines. An example taken from the aerospace world is the design of smart airfoil skins. The skin of a wing airfoil is a thin layer of material that gives the airfoil its aerodynamic shape. It also protects the interior of the wing from excitations that might come from the outside—wind gusts or the impact of a projectile. A conventional skin (typically just a curved sheet of metal) could be replaced with a metamaterial layer equipped with wave-controlling capabilities that could steer and reroute the energy, preventing it from reaching the interior of the airfoil and causing damage.

Figure 6. Locations of AE up to about 95% of peak stress (blue) and around peak stress (red). Microcracking was more or less random prior to peak, but a localized region corresponding to the eventual fracture is clearly identified.

Figure 7: Wave manipulation in phononic metamaterials. Top: Experimental proof of concept of waveguiding in a plate with resonating stubs realized using Lego® bricks. Bottom: Discretely telescopic stubs with variable resonant characteristics; the brick-enabled experimental platform allows switching configurations and exploring designs with remarkable speed and ease.

Figure 8. Demonstration of wave control capabilities in lattice materials using laser vibrometry. Left: Lab setup for a scan of a perforated aluminum slab experiencing flexural waves. Right: Snapshots of measured wavefields revealing switching between x-shaped pattern at low frequencies and + shaped pattern at high frequencies.
DEPARTMENTAL SCHOLARSHIPS

The Simon and Claire Benson Award is awarded each spring to an undergraduate student. Established in 1986, the award recognizes outstanding undergraduate performance. It is named in memory of two former outstanding Civil Engineering undergraduates, brother and sister, who were tragically killed in a car accident in August 1986. Claire received the award in 1985; Simon graduated one year before the award was instituted, but would have been a worthy recipient.

2016 recipient: Sophie Kasahara

Al Johnson Construction Co. Scholarship
Doug Novak

Andrew Drescher Scholarship
Emily Erhart

Bonestroo, Rosene, Anderlik & Associates Undergraduate Scholarship
Riley Brown
Daniel Kennedy
Isabel Panek

CEGE Scholarship
Patrick Buffington
Alyssa Wolfe

Clifton T. Barker Scholarship
John Connelly
Henry Croll
Tyler Greene
Doug Novak

Dennis R. and Catherine M. Martenson Scholarship
Rena Weis
Noah Germolus
James Butler

Donald and Louise Ruhnke Scholarship Fund
Jeremiah Hamlin
Carl Duebner
Reed Kaepp
Eliza Jade Balcos

James and Sharon Weinel / Chi Epsilon Scholarship
Corin Treat

James Grant Waits Undergraduate Scholarship
Henry Croll

John Elwood Holmberg Memorial Scholarship
Jordan Hurst

John G. Williams Memorial Scholarship
Jeremiah Hamlin

Mike Costello Memorial Scholarship
Emily Ehart

Richard Dennis Memorial Scholarship
Rena Weis
Noah Germolus
James Butler
Brady Halvorson
Acadia Stephan
Yunis Adam
Emily Castanias

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Corin Treat

Sommerfeld Undergraduate Scholarships
Alexander Rude
Caleb Widstrand
Chen Hu
Christopher Grapentin
Daniel Kennedy
Diego de Bedout
Edqin Antonio Jarquin Martinez
Girmaye Tilahun
Haile Werke
Isabel Panek
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Joel Johnson
Kara Yetter
Patrick Buffington
Riley Brown
Riley Gordon
Robert Rudin
Ryan Heath
Sam Lombardo
Tadesse Saiifu
Tyler Gilbert
Yousen Foo
Zi Yao Ngai

Theodore V. Galambos Scholarship
Alyssa Wolfe
Jordan Hurst

COLLEGE OF SCIENCE AND ENGINEERING SCHOLARSHIPS

3M/Coleman Family Foundation Scholarship
Kaitrin Colby
Bryce Heller
Mitchell Kiecker
Douglas McCuney-Zierath
Joshua Pierce
Trevor Przybyla
Robert Rudin

CSE Alumni Scholarship Fund
John Connelly

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Russell J. Penrose Undergraduate Endowed Scholarship II
Isabel Panek

Vorpahl Family Memorial Scholarship
Darrin Rickbeil
Scott Fiodin

Westwood Professional Services Scholarship
Gabriel Micheletti

William H. Burgum Scholarship
Aileen Zebrowski
Fall 2016

We invite you to join us for our Fall 2016 season of the Warren Lecture Series. We bring in lecturers from around the world to share research and ideas with CEGE faculty, students, and friends.


These lectures are made possible by a generous, renewing gift by Alice Warren Gaarden.

FALL SCHEDULE

SEPT 9  JIAN-SHIUH CHEN  
Civil Engineering, National Cheng Kung University, Tainan, Taiwan

SEPT 16  AHMED ETTAF ELBANNA  
Civil and Environmental Engineering, University of Illinois at Urbana-Champaign

SEPT 23  YONGGANG HUANG  
Civil and Environmental Engineering, Northwestern University

SEPT 30  GRAEME MILTON  
Mathematics, University of Utah

OCT 7  SPECIAL WARREN LECTURE IN HONOR OF ROBERT DEXTER  
ROBERT CONNOR  
Civil Engineering, Purdue University  
*Note Special Time: 3:30 PM

OCT 14  (TO BE ANNOUNCED)

OCT 21  SPECIAL WARREN LECTURE IN HONOR OF IOANNIS VARDOUNAKIS  
PANOS PAPANASTASIOU  
Civil and Environmental Engineering, University of Cyprus

OCT 28  P. BENSON SHING  
Structural Engineering, University of California, San Diego

NOV 4  AVINASH UNNIKRISHNAN  
Civil and Environmental Engineering, Portland State University

NOV 11  CHRISTY REMUCAL  
Civil and Environmental Engineering, University of Wisconsin-Madison

NOV 18  (TO BE ANNOUNCED)

DEC 2  TIM LAPARA  
Civil, Environmental, and Geomatics Engineering, University of Minnesota

DEC 9  SEVINC SENGOR  
Civil and Environmental Engineering, Southern Methodist University

Recordings are available on our website at www.cege.umn.edu.
Robert Rudin is the first in his family to become an engineer. His father and grandfather, in addition to passing along their name, passed on an affinity for science and numbers. He got another strong dose of technological ability from his mother, a computer systems analyst. It seems young Robert was predestined for the sciences.

His science interests were further stimulated when he encountered a passionate chemistry teacher in junior high. Mr. Ellingson had traded his successful industrial career at 3M for the privilege of inspiring young minds through chemistry. Ellingson was “very into” chemistry, prompting Rudin to declare that he “never felt forced to learn anything.” He’d caught Ellingson’s passion.

Rudin is a hands-on person who seeks out practical applications for his knowledge. When he came to the University of Minnesota, Rudin found his ideal mix of science and application in civil engineering, where the CEGE curriculum encourages students to experience multiple areas of civil engineering. He decided to emphasize environmental engineering and minor in chemistry. Rudin’s decision to focus on environmental engineering was influenced by his desire to preserve the environment while still being able to enjoy it. He is on track to graduate in the spring of 2017, four years after enrolling.

Last summer, Rudin participated in an undergraduate research program with the National Transportation Center at the University of Maryland. He worked on developing a model looking at various socioeconomic factors (jobs, location) and how they might influence a person’s automobile possession and use (number of cars, model, mileage, etc.). One application of this model could be to estimate air pollution for an area based on those factors. He used “R” programming software (which he also used in transportation classes at UMN) to comb through large data sets and identify factors important for the new model. A second project involved writing a business case evaluating the feasibility of the state subsidizing a short-line railroad and comparing that to other options such as trucking. Rudin’s interests include history and politics, so he loved the opportunity to spend time close to DC. It led him to think about one day bringing his engineering expertise to consult on public issues or projects.
This summer, Rudin worked in an environmental research laboratory at UMN under the guidance of Professor Bill Arnold and doctoral candidate Jill Kerrigan. “It has been a great opportunity to experience a working lab. I participate in the weekly update meetings and hear about all the research going on in Professor Arnold’s group.”

Kerrigan’s research involves examining soil cores from lake sediment and determining trends in antibiotic concentration over time. Rudin helps concentrate and analyze the sediment. “The project is more complex than I expected. I was surprised about all the steps involved in preparing the samples for analysis—concentrating the sample and ensuring that it does not get contaminated; many simple things can cloud the data. It has also been really cool to go into the UMN Cancer Research Center and to see the liquid chromatography tandem mass spectrometer. As a student researcher, I am very lucky to have access to such impressive equipment.”

Rudin is not an “all work” kind of guy, however. He keeps up with his family (twin brothers: one studies architecture at UMN, and the other studies computer science at UMD), friends, and his girlfriend Megan. And Rudin is the drum major for the University of Minnesota Marching Band. Getting all this done requires balance.

“It’s like a teeter-totter: the goal is to keep everything balanced, but not necessarily static. Priorities are constantly shifting up and down, always in motion, but overall, balance is maintained.”

His friend, a former drum major, inspired him to try out for the drum major role. The position is competitive and entails more than most people expect. The drum major leads the band through example, teaches marching fundamentals (developing lesson plans and guiding practice on the field), promotes the band, conducts the band during games and parades, and works with other band leaders to coordinate events.

The audition process is quite rigorous, lasting two-and-a-half months. It includes interviews, training, and performances. It was a stretch for Rudin to put himself out that way. It is one thing to be one player in a very large band and quite another to be out in front as a solo performer. Rudin did not make the cut the first time he auditioned, but gained a lot of confidence through the audition process. The confidence he gained helped him pursue other goals and made him much bolder about trying new things. He was successful in his junior and senior years.

“IT put in a lot of time, but so do all the band members. We all contribute different pieces. I rarely do anything alone.”

Rudin has kept his grades up and earned some merit-based scholarships, including the 3M/Coleman Family Foundation Scholarship, which was created by alumnus and football fan H. Richard (Dick) Coleman (BCE, 1973). As the drum major, Rudin is usually pretty busy during Gopher football games, but last season he was able to meet and thank Coleman on the field before a game. (The 3M/Coleman Family Foundation Scholarship has now supported more than 50 civil engineering students.)

Being the drum major precludes Rudin’s involvement in some of the extra-curricular engineering activities. Yet he has good relationships with his classmates and often works with them on the more difficult assignments.

Interesting factoid:

About 30% of the marching band members are from the College of Science and Engineering.
He also appreciates his relationships with his professors. "I've discovered that all the CEGE professors want to teach you what they know. I've had some really good professors who have taken time to work with me when I struggle with the material.

"For example, I was not particularly interested in structures, and that class was a struggle for me. Professor Lauren Linderman answered my many questions and helped me learn the material. I have to say I am more interested, now—I appreciate all that goes into creating a structure, even a small apartment building."

"I had an environmental remediation technology course with Professor Ray Hozalski. He is very personable and passionate about what he studies. I ran into him on the bus; he knew my name. It was easy to talk to him and to explore my interests through his. That is true of plenty of other professors, too."

"Fall semester I am taking a Grand Challenges course, Global Venture Design: What impact will you make? [The course considers how small teams of motivated individuals can move from understanding a global problem—renewable energy, public health threats—to creating impact through business start-ups.] I am looking forward to exploring my future career focus. I am thinking about an environmental position where I can use my chemistry experience, and I'm most interested in exploring environmental and biomedical fields. At this point, I am also open to graduate school and diving more deeply into environmental engineering research."

Related Story:

Drum major photos taken by Mike Wang and Colin Maraganore.
The CEGE Capstone Design course is a unique experience for our students and unique among engineering programs. Our community partners are essential to making the Capstone course a success.

Capstone Design pairs student teams with practicing, professional engineers from firms and organizations in the Twin Cities area. Together they solve real-world engineering challenges. Most of the projects are local, but some have been located overseas, for example, in Somalia and Honduras—electronic communications are useful in these situations.

The benefits these projects hold for students are perhaps obvious: experience, application, specific mentoring, teamwork, exposure to professional practices and professional offices, and confidence from completing a project. In the face of these payoffs, students are invested and work hard to be successful.

Benefits for mentor firms are also abundant. We hear many comments about the gratification of working with young engineers and about the pride and fulfillment that comes from contributing to the future of the field. Tangible benefits also accrue: continuing education credits and meeting some possible future employees, not to mention the work the students produce. We would love to have you join in and experience these benefits, too!

Here is how it works. Mentors supply a project for students to work on over one semester. Students choose a project based on their interests. Once teams are assigned, mentors meet regularly with their student team, usually about two hours a week—varying, of course, with the type and stage of each project. As the projects progress, mentors may provide background information, technical assistance, or guidance. Mentors are encouraged to let students make important, project-related decisions. Mentoring does require a time commitment, and so we are very grateful for the engineers and firms who step up.

Students get input from course instructors and other experts as well. In class, students study ethics, communication, teamwork, public policy, business models, and the process leading to licensure. The final output of the students’ work is a report, but may also include a set of contract documents. Students present the report orally and in writing for instructors and mentors, and sometimes for the client.

The Capstone Course is offered each semester. To participate in this valuable and rewarding endeavor, contact Cathy French, Director of Undergraduate Studies (cfrench@umn.edu).

We thank the following firms who have offered Capstone projects within the last year.

**Alliant Engineering, Inc.:** Thomas Jensen, PE  
**Barr Engineering:** Joel N. Swenson, PE, Raul Velasquez, Ph.D.  
**Bay West:** Bob DeGroot, PE, PG, and Jonna Bjelland, EIT, Donovan Hannu, PE, Matt Schemmel, PG, and Jonna Bjelland, EIT  
**BKBM Engineers:** Tierney Broberg, EIT, and Katie Meehan, EIT  
**City of Edina:** Chad Millner, PE, and Carter Schulze, PE  
**DLR Group:** John A. Tinker, PE, SE, Daniel Caron, EIT, and Aly Carney, EIT  
**HGA:** Lauren Snyder, Anton Tillman, Andrew Atkins, PE, and Jon Weaver, PE  
**Kimley-Horn:** Brian Wurdeeman, PE, and Marco Weidmer, EIT  
**LimnoTech:** Craig Taylor, PE, and Nick Grewe, EIT  
**Meyer Borgman Johnson:** Tina Benedict, PE, Matt Smith, PE, Eric Corwin, PE, and Saura Jost, PE  
**MnDOT Bridge Office:** Tony Lesch, PE, and Ashley Grzybowski, PE  
**MnDOT Office of Materials & Road Research:** Rich Lamb, PE, and, Bernard Igbeni Izevbokhai, PE, Ph.D.  
**SRF Consulting Group, Inc.:** Emily Gross, PE, Joseph DeVore, EIT, and Clayton Bayer, EIT, Tom Sachi, and Walter Eshenaur, PE  
**TKDA:** Bob Krussow, PE, LEED AP  
**USDA–Natural Resources Conservation Service:** Scott Swanberg, PE, and Amanda Smith, PE  
**WSB & Associates:** Janelle Borgen, PE, PTOE, and Katy Thompson, PE, CFM
Steven Crouch has been Dean of the College of Science and Engineering for over a decade. On August 31, Crouch stepped down as Dean and passed the torch to his successor, Samuel Mukasa.

Under Crouch’s leadership, the College has produced more than 15,500 science and engineering graduates, many of whom are now in leadership positions around the world. His legacy was honored with the establishment of The Steven L. and Karen L. Crouch Endowed Scholarship Fund, funded with an initial contribution of $100,000 by board members and CSE campaign volunteers. Additional donations to the fund are welcome. The named scholarship will be used to provide scholarships for College of Science and Engineering students.

Samuel Mukasa previously served as the dean of the College of Engineering and Physical Sciences and Eric J. Essene Professor of Geochemistry at the University of New Hampshire. Prior to his role at the University of New Hampshire (UNH), 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 holds a Ph.D. in geochemistry from the University of California, Santa Barbara, an M.S. in geology from Ohio State University, and a B.S. in geology from UNH. He is highly regarded for his research in geochemistry, geochronology, and petrology.