

UND

2021

ENGINEERING



New Degree & Certificate Programs Approved

page 12

UND Becomes First University in New U.S. Space Force Program

page 23

Powering Up North Dakota's Energy Future

page 14

NEW PROGRAMS.
NEW OPPORTUNITIES.

The UND College of Engineering & Mines is proud to announce the new Bachelor's in Biomedical Engineering degree program, as well as certificate programs in secure networks, ethical hacking, and cyber security.

Read more on page 12.

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2021

UND ENGINEERING

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LETTER FROM THE DEAN



Hello CEM Alumni and Friends,

Greetings from Grand Forks!

We are delighted to bring you this latest issue of our Engineering magazine. As you will see throughout these pages, our faculty, staff, students, and alumni have not let the pandemic slow down the great things they are doing. From starting new programs to partnering with the Space Force to honoring our alumni, this has been a very busy and fun year in CEM.

It is an honor to serve as the Dean of the College of Engineering and Mines, and I feel immense gratitude for those who have helped us remain strong throughout this pandemic.

First of all, I am very proud of our faculty and staff, who quickly adapted in order to serve our students, conduct innovative research, and collaborate with one another under a new set of constraints. Secondly, I'm thankful for our students, who demonstrated an impressive amount of grit and perseverance while navigating additional challenges during the pandemic. As you will read here, our faculty and students have continued to be involved in many inspiring projects, advancing technology and helping to make the world a better place.

Finally, I am extremely grateful for our alumni and friends, whose support is vital in so many ways.

Support from CEM alumni for the Open Door Scholarship and the Angel Fund was especially strong and raised the bar for the rest of the university. We are also fortunate to have established several new endowments this year for scholarships and faculty support. These endowments will have an impact on everyone in CEM and everything we do for the foreseeable future. Our donors have helped make a college education more affordable for students, attract and retain high-quality faculty, and help update lab facilities and equipment.

As we look to the future, we are committed to upholding our strong tradition of undergraduate teaching while also growing our research capabilities in critical areas such as data science, infrastructure, and national security. We have ambitious plans to grow our enrollment, expand our faculty, and renovate our buildings. I look forward to having the opportunity to share those plans in more detail with each one of you.

On behalf of our faculty, staff, and students, thank you so much for your support of CEM. I wish you all the best and hope we can see each other soon. Please take care and stay safe.

Brian Tande, Ph.D.
Dean, College of Engineering & Mines

MESSAGE FROM THE EXECUTIVE BOARD



TERRY SEVERSON
BOARD CHAIRMAN

Well, that was a year and more... we did maintain Executive Board activities with Zoom meetings in October and April—but we were definitely ready to resume normal activities this fall with our Homecoming 2021 Board meeting held in person again. It was reassuring to see CEM student enrollments remain steady and academic operations adjust, adapt, and continue throughout the period. It certainly helped to have successfully delivered Distance Learning for more than 30 years, so it was a much shorter step for CEM to convert entirely to Distance Learning during the COVID shutdown.

We were pleased that President Armacost, an industrial engineer himself as you likely know, joined us for an hour's discussion during our April Board meeting. One of his major topics was his UND Space/National Security Program initiative which he's energetically advocating. CEM, of course, has a significant role to play in this endeavor along with Aerospace. It's impressive how rapidly that initiative is gaining substance, e.g., ND Legislature funding, ND Congressional delegation

support, US Space Force University Partnership Program, and Space Development Agency's prototype satellite launch with a Grand Forks AFB control site and with General Atomics (Grand Sky) participation.

CEM's potential participation would include research projects, student internships, and jobs after graduation. It's a great example of every element—UND including CEM, Aerospace, and other colleges; state and local government; and US Space Force and Air Force—contributing to and benefiting from a robust new national security technology enterprise in and around UND/Grand Forks.

That's only one of the numerous positive initiatives underway within CEM. New engineering programs are being approved and implemented including Biomedical, Systems, Cybersecurity, and Aerospace. CEM partnerships have been established with Rize Education, a consortium of smaller four-year colleges nationwide, and with Bismarck State College to serve all of Western ND. The DRACOLA Drilling Lab (one of a kind in the world) held a



STEVE BURIAN
BOARD VICE CHAIRMAN

dedication/grand opening ceremony this fall during Homecoming. The facility is located in the old Minnkota Power facility, along with a pilot plant to produce Rare Earth Elements, and a wind tunnel. Finally, there's a UND Master Plan effort underway which includes a close look at facility alternatives for CEM. (After all, Harrington Hall wasn't new when Terry arrived in 1960.)

It's these types of CEM initiatives, activities and enthusiasm that make it so interesting and rewarding to serve on Dean Tande's Executive Board and have the opportunity to lend assistance and encouragement to him and his faculty and staff.

ALUMNI ACADEMY INDUCTION CEREMONY

2021



OUR NEWEST ALUMNI ACADEMY INDUCTEES

On October 22, 2021, we welcomed three new members into our Alumni Academy: (from left to right) A. Benjamin Dove, Ronald A. Apanian, and Mark W. Thompson.



ALUMNI ACADEMY MEMBERS REUNITE

During the Alumni Academy Ceremony, we were honored to be joined by many of our current Alumni Academy members: (from left to right) Jim Albrecht, Dean Wieland, Chuck Kummeth, Ben Dove, Craig Olson, Ron Apanian, Steve Burian, Mark Thompson, Mike Lodoen, Terry Severson, and Dwight Wendschlag.

2021 ALUMNI ACADEMY INDUCTEE

UND College of Engineering and Mines ACADEMY

Ronald Anthony Apanian



Born: October 17, 1934, Bottineau, North Dakota, USA
Education: University of North Dakota, BSCE, 1956
University of North Dakota, MSCE, 1958
Lambda Chi
Oklahoma State University, Ph.D., 1967

Career Experience

1956-1957 GTA, UND Civil Engineering
1957-1958 Instructor, UND Civil Engineering
1958-1965 Assistant Professor, UND Civil Engineering
1967-1974 Associate Professor, UND Civil Engineering
1973-1999 Department Chair, UND Civil Engineering
1974-1999 Professor, UND Civil Engineering
1999 Professor & Chair Emeritus, UND Civil Engineering

Recognitions

National Science Foundation Faculty Fellow; 1965-1967
Elwyne F. Chandler Award from the ND Society of Professional Engineers and Land Surveyors in recognition of outstanding contribution to the advancement of the engineering profession
Recognized by ND Governor Jack Dalrymple for 52 years of service with the Society of Professional Engineers and Land Surveyors

Achievements

Established the Ronald A. Apanian Master of Civil Engineering Research Support Endowment
Sigma Tau Honor Society Member
ASCE Life Member since 1956

Service

North Dakota Board of Registration for Professional Engineers (two terms); Chair (one year)
Grand Forks City Board of Appeals
Member of the American Society for Engineering Education; served on the Accreditation Board
Member of the American Society for Civil Engineers; served as Faculty Advisor
Sigma Tau Honor Society Faculty Advisor
Served the committee that was instrumental to establishing the Order of the Engineering ceremony at UND

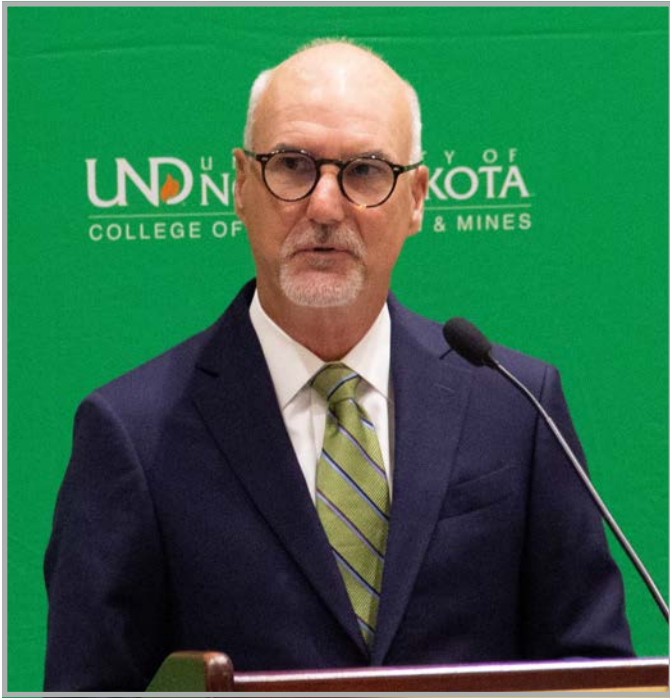
UND CIVIL ENGINEERING
UNIVERSITY OF NORTH DAKOTA



**RONALD A.
APANIAN**
Class of '56 & '58



Apanian Family: Laura, Brenna, Terri, Steve, Roni, Dan, Cris, Ron and Joy Bostrom.



A. BENJAMIN
DOVE
Class of '83

UND College of Engineering and Mines
ACADEMY
A. Benjamin Dove, IV



Born: May 2, 1961, Mandan, North Dakota
Education: University of North Dakota, BSME, 1983
University of Pennsylvania, MSSE, 1994

Career Experience

1984-1990 Systems Engineer, GE Aerospace (Lockheed Martin)
1990-1992 LM Mission Operations Manager
1992-1994 LM Chief Engineer, classified development project
1994-1997 LM Systems Engineering Manager, classified development program
1997-2001 LM Engineering Manager, classified development program

2001-2004 LM Program Director, classified development & support program
2004-2006 LM Program Director, US Air Force AEHF Satellite Ground System
2006-2008 Lockheed Martin Business Unit Director of Program Execution
2008-2013 LM Business Unit, VP of Performance Excellence
2014-2016 LM Business Unit, Director of Engineering Operations
2016 Retired from Lockheed Martin
2018-Present Business Consultant Leidos Corporation

Recognition & Accomplishments

GE General Managers Award 1992
LM Leadership Excellence Award 1999
National Reconnaissance Office Certificate of Recognition 2000
LM One in a Thousand Award 2001
LM Certified Program Manager
Chaired LM Program Management Council
Received numerous customer 100% Award Fees and 5.0 CPAR ratings
As a Program Manager, through customer collaboration and mission execution focus, grew contract value to >\$1B

Volunteer Service/Interests

UND CEM Executive Advisory Board
Moringa Community School of Technology (Ghana)
Social Venture Network – Impact Investor
Philadelphia Alliance of Capital and Technologies
American Red Cross
Completed 3 marathons, 3 holes-in-one (to date)



MARK W.
THOMPSON
Class of '71

UND College of Engineering and Mines
ACADEMY
Mark W. Thompson



Born: April 2, 1948, Bismarck, North Dakota, USA
Education: University of North Dakota, BSME, 1971

Career Experience

1971-1975 United States Air Force KC-135 Navigator
1975-Present Owner & President, H.A. Thompson & Sons
Mechanical Contractor, Bismarck

Service

1977 Council President, Lutheran Church of The Cross
1985 President, Bismarck Farwest Rotary
1992 President, North Dakota Plumbing, Heating, and Air Conditioning Contractors Association
2002 Rotary District Conference Chairman
2016 Rotary District Conference Chairman
2009-2019 Bismarck Public Schools Foundation Board
2011-2021 Sanford West Foundation Board
2011-Present Linc Advisory Council

Awards

Air Medal, Linebacker II, Vietnam
The Granite Award for Outstanding Community Service, Bismarck-Mandan Chamber of Commerce
Don Lehr Passion for Business Award, The Linc Corporation
Sanford West Foundation Directors of the Year with wife Claudia (Education '70), 2016
Vicki Clark Award for Outstanding Family Business of the Year, Prairie Family Business Association, Sioux Falls, South Dakota, 2017
Bismarck High School Hall of Fame, Inducted 2017

H.A.
Thompson
& SONS
SINCE 1908

"Plan the flight, fly the plan, but always have a Plan B!"



Ben pictured with wife Donna and his mother Barbara.



Thompson Family: John, Tracy, Drew, Emma, Jennifer, Mark and Claudia



ANNOUNCING OUR NEW ENDOWMENTS

Tom & Carolyn Hamilton Faculty Fellowship Endowment

The Tom (M.S. Geology, '67 & Ph.D. Geology, '71) and Carolyn Hamilton endowment will support a faculty member within the College of Engineering and Mines as recognition and tribute to excellence in teaching and/or research.

Michael and Sitney Lodoen Endowed Professorship in Civil Engineering Endowment

The Michael (B.S. Civil Engineering, '65) and Sitney Lodoen endowment will support a faculty member in the Civil Engineering Department within the College of Engineering and Mines as recognition and tribute to excellence in teaching and/or research.

Terry and Diane Severson Endowed Professor of National Security

The Terry (B.S. Electrical Engineering, '65) and Diane Severson endowment will support a faculty member within the College of Engineering and Mines as recognition and tribute to excellence in teaching and/or research.

Mark and Claudia Thompson National Security Faculty Fellowship Endowment

The Mark (B.S. Mechanical Engineering, '71) and Claudia Thompson (B.A. Education, '70) endowment will support a Faculty Fellow in National Security within the College of Engineering and Mines focusing on excellence in teaching, service, and research.

"The College is very grateful to the generous donors who established these endowments. They will allow us to recruit and retain excellent faculty who can inspire our students and conduct impactful research."

Brian Tande, Ph.D.
Dean, UND College of Engineering & Mines

NEW ENGINEERING DEGREE, CERTIFICATE PROGRAMS APPROVED

UND College of Engineering & Mines to offer bachelor's degree in biomedical engineering, three new cybersecurity certificates

To meet strong employer demand, the College of Engineering and Mines (CEM) at the University of North Dakota will now offer a bachelor's degree in biomedical engineering as well as three new certificates for master's students.

The four new academic programs, which include graduate-level certificates in cyber security, ethical hacking and secure networks, received approval by the North Dakota University System in early May. Students will be able to pursue the new offerings as early as Fall 2022.

"Our new biomedical engineering bachelor's degree, as well as our new grad certificates, complement our existing programs and offer more opportunities for us to serve students and meet the needs of employers in our region," said Brian Tande, dean of the College of Engineering and Mines.

Biomedical Engineering

The bachelor's degree in biomedical engineering (BME), a discipline that applies engineering principles to improve human health, is the first such program in North Dakota. It is the latest embodiment of CEM's years-long focus on BME.

Currently, the College offers a BME minor as well as a BME-focused electrical engineering program, which collectively serve more than 20 students. The College also has a graduate-level BME program, which since its inception four years ago has graduated

six master's students as well as two Ph.D. students who will defend their dissertations this year. Today, there are more than 30 students in the graduate BME program.

The bachelor's BME curriculum will build on the courses CEM already has and incorporate new classes such as "Computational Biology" and "Biomedical Imaging." Students will also study biology, chemistry and electronics, among other topics.

"Biomedical engineering is highly interdisciplinary, and we envision this program leading to many collaborative student projects with industry and across UND, including with the School of Medicine and Health Sciences and the College of Arts and Sciences," said Kouhyar Tavakolian, associate professor and director of the program.

The goal is to provide a BME program that helps stimulate economic development in the medical device sector in the state at large, and Grand Forks in particular. The program will use an innovation-based learning pedagogy to prepare engineers who will tackle real-world problems and work directly with established companies while at UND. A BME bachelor's degree can also serve as a launching pad to medical school.

Cybersecurity certificates

Focused on the latest developments in cyber security, the three certificate programs will equip students with the skills required to meet the ever-increasing needs of government and private employers operating in a digital-first world.

For example, the certificate in secure networks will cover topics such as cryptography, communication protocols and application-layer security, the importance of which has risen with the advent of 5G broadband services.

The certificate in ethical hacking will teach students how to identify and assess the vulnerabilities of different computing systems through penetration testing and secure software engineering, among other tools.

The cyber security certificate will also hone on digital risks posed by emerging systems and human factors. It will prepare students to respond to the growing presence of cyber threats in private and public business activities as well as the nation's defense industry.

CEM anticipates that nearly 200 UND students will pursue at least one of the certificate programs at any given time. All three certificates build on the cyber security programs available to undergraduate and graduate students at the University.

These new certificates reflect the changing landscape of higher education credentials, largely driven by students and industry. "On their way to earning a master's degree, students will be able to complete these three industry-recognized certificates that can differentiate them as they enter this rapidly growing industry," said Ryan Adams, professor and director of the School of Electrical Engineering and Computer Science.

Written by Dima Williams



UND AND BISMARCK STATE COLLEGE ANNOUNCE COLLABORATIVE ENGINEERING DEGREE

Bismarck State College (BSC) and the University of North Dakota have created a collaborative engineering program that will result in a Bachelor of Science degree in Engineering from UND, earned on the BSC campus.

On Tuesday, Jan. 26, leaders from the two institutions signed an agreement that will create a pathway for students to complete their engineering bachelor's degree in Bismarck.

"I am thrilled to sign this program agreement that will connect academic programs offered by BSC and UND," said UND President Andy Armacost. "Both institutions are focused on academic excellence, and this new agreement will enable BSC students to readily earn both their associate degree and ultimately their bachelor's degree in engineering. This is an amazing program that will allow both institutions to contribute

to developing well-educated graduates and technical leaders for the State of North Dakota."

"As a polytechnic institution, our mission is to create career pathways for students and create economic opportunity for business," said Bismarck State College President Doug Jensen. "This partnership exemplifies both of those goals. It provides a high-quality collaborative program to students in a convenient, timely, flexible and cost-effective manner right here in Bismarck. It makes an engineering degree more feasible for those aspiring to be an engineer and builds the talent needed in the business community."

Students in the new four-year engineering program option will benefit from BSC's strong pre-engineering program as well as UND's 31-year history of distance education in engineering.

After completing their associate degree from BSC, students will transition into the UND distance program to complete their ABET-accredited bachelor's degree with local support from both BSC and UND.

The BSC/UND collaborative engineering program includes Bachelor of Science degrees in Chemical Engineering, Civil Engineering, Electrical Engineering, Petroleum Engineering and Mechanical Engineering.

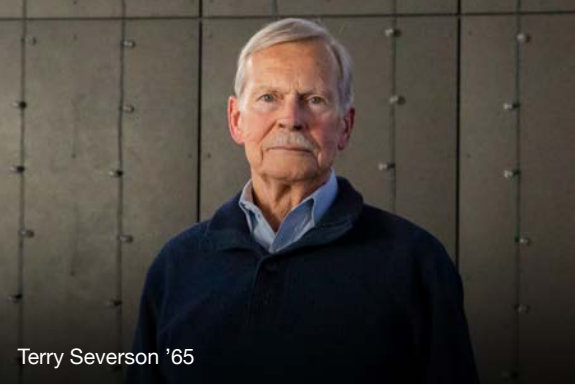
"We are very excited to partner with BSC to offer a pathway for students in Bismarck to earn an engineering degree," said Brian Tande, dean of the UND College of Engineering & Mines. "By working together, our two institutions have developed a cost-effective way for students to become engineers and take advantage of opportunities at both schools. As a native of Western North Dakota, I'm especially happy the College of Engineering and Mines will have a greater presence in this part of the state and, together with BSC, train more engineers to help grow the economy of our state."

Both campuses will maintain compliance with state and national accreditation guidelines and the collaboration will benefit the engineering workforce needs of the region and beyond by providing high-quality engineering graduates.

New students interested in this engineering degree pathway can apply for the Fall 2021 semester at bismarckstate.edu/apply. Current BSC pre-engineering students should apply at und.edu.



Erwin '83, '85 & Colleen, '84, '85 Martens



Terry Severson '65

CEM ALUMNI HONORED AT SIOUX AWARD CEREMONY

This year, we celebrated as two of our CEM alumni, Terry Severson and Erwin Martens, received the Sioux Award - the highest honor given by the UND Alumni Association & Foundation for achievement, service and loyalty. Since its inception in 1962, this distinguished award has been presented to leaders in government and business, high achievers in various professions and alumni who have dedicated their lives in service for others.



WATCH THEIR SPEECH

Scan with your phone's camera app to watch the Martens' introduction and speech at the 2021 Sioux Award Ceremony.



WATCH HIS SPEECH

Scan with your phone's camera app to watch Terry's introduction and speech at the 2021 Sioux Award Ceremony.



POWERING UP NORTH DAKOTA AND THE WORLD'S ENERGY FUTURE

UND dedicates one-of-a-kind engineering facility for training and research

A building that once generated electricity for Grand Forks and the surrounding region will help lead North Dakota's energy industry to new techniques, technologies and training opportunities.

On Oct. 22, UND's College of Engineering & Mines (CEM) formally dedicated and held a grand opening for the Drilling & Completion Lab (DRACOLA) and Research Facility in the former Minnkota Power Cooperative power plant building in Grand Forks.

DRACOLA will enable UND petroleum engineering students to gain firsthand experience on a working drilling rig, as well as assist North Dakota's oil and gas industry in testing equipment and drilling techniques. Another major research effort in the building is a pilot-scale plant to extract valuable rare-earth elements from North Dakota lignite coal. A third project is a wind tunnel to test unmanned aircraft system (UAS) designs.

"This facility is a symbol of our commitment to serving North Dakota," said Brian Tande, CEM dean. "The projects taking place here support two of our largest and most important industries: the oil and gas industry and lignite energy industry."

"The facility also supports emerging industries like unmanned aircraft systems (UAS) and geothermal," he continued. "And it addresses rare earth elements, an area of significant concern to our national security. As a native of this state, I'm very proud of the work that we are doing here."

UND President Andy Armacost, who cut the ribbon during the dedication ceremony, said, "This facility is a collection of organizations and people with a strong interest in the economy of North Dakota and the oil and gas economy across the United States."

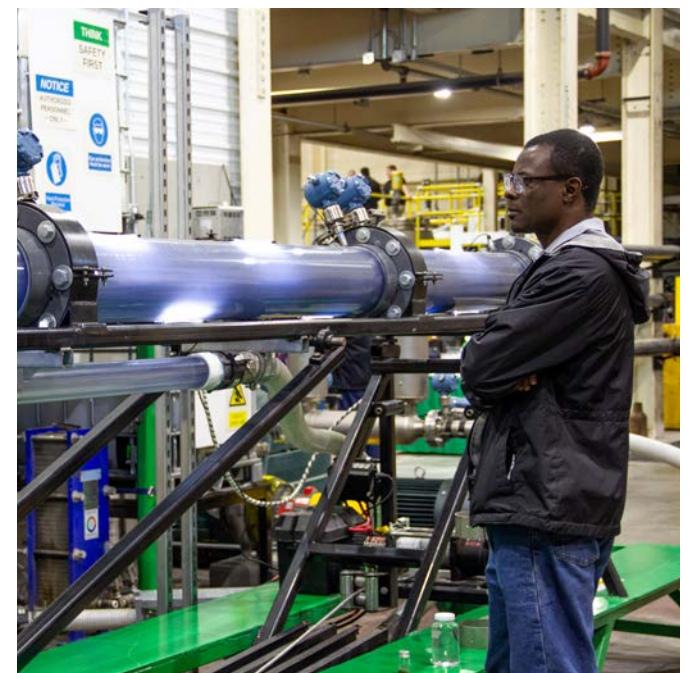
"The result is a great facility where we can test out new technologies, new ideas, involve students and faculty members in that work, and really build those partnerships with industry," he added.

During his remarks, Tande recalled how all the pieces came together two years ago to make the CEM research facility a reality. It started when Sidney Green, founder and retired CEO of TerraTek, approached UND with the idea of gifting the drilling lab simulator to UND. Vamegh Rasouli, petroleum engineering chair, and Harry Feilen, now the DRACOLA director, played a lead role in bringing one of the world's largest drilling simulators to UND.

In remarks recorded for the dedication ceremony, Green said, "When I was considering where this facility would go, a number of universities became very interested – several to the point of very strongly indicating they wanted the laboratory."

"But only one – UND and Professor Rasouli – really had the vision of the laboratory's capabilities and had someone like Harry Feilen who could set up and operate a large-scale testing facility," he said. "As I met with them, I quickly concluded that this is a group that could take the equipment and really do something with it. I was convinced right away."

At the same time, Tande said research on extracting rare earth elements from North Dakota coal was gaining steam. Michael Mann, CEM associate dean for research, and his team needed a location to build a pilot plant to scale up the process toward commercialization.



"This is an important project that has national security implications, as well as the potential to create an entirely new revenue stream for lignite producers and the state of North Dakota," Tande said.

In addition, Forrest Ames, a professor in the CEM mechanical engineering department, needed space to build a wind tunnel to support work on unmanned aircraft.

As Tande noted, "With all of these projects coming together, we were very fortunate to find this facility that could accommodate all three."

"This is fabulous!" exclaimed Kathy Neset, CEO of Neset Consulting in Tioga, N.D., and former State Board of Higher Education member, after touring the drilling lab.

"You read in a textbook, you listen in class, but until you get out on a drilling rig out in the field and really see the operation, you can't appreciate what's going on," she explained. "When you have students and

researchers who can utilize a lab like this, they will be miles ahead of others who are doing the same thing in other locations."

Commercializing the process to extract rare earth elements from North Dakota coal represents not only a potential new market for the state's abundant lignite resources, but also addresses a national security concern. China produces most of the world's rare earth elements, important components in everything from electric cars to smartphones to electronic sensors and radars.

Nolan Theaker, technical group manager on the rare earth project at the CEM Institute for Energy Studies, said the project has received support from the North Dakota Industrial Commission, the Lignite Energy Council and the mine and power plant operators in the state.

"Our plan is to process a couple hundred tons of that coal here and give them all the

information they need to go out and build their commercial plant," he said. "We'll act as support for those commercial plants."

"We're expecting that January through March, we'll be producing rare earth elements in kilogram quantities, which will be some of the first rare earths produced at that scale from lignite resources," he continued.

Theaker said the U.S. Department of Energy has set an aggressive timetable for commercial production of rare earth elements.

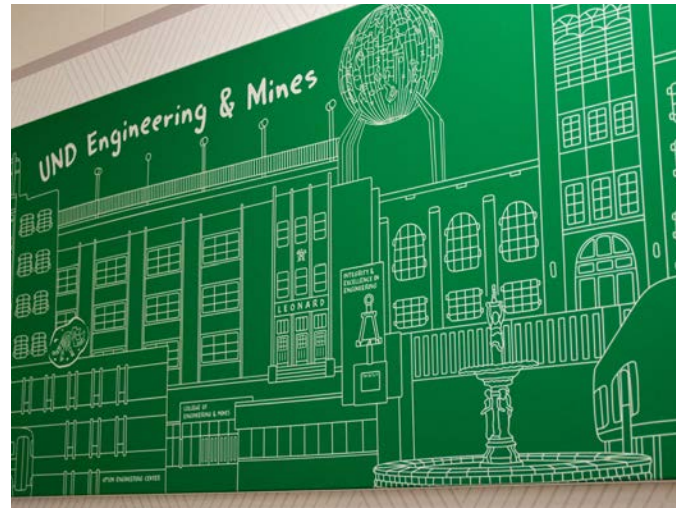
"In the next three years, we expect this technology to be real and out in the field," he said. "That would be right beside one of our North Dakota mines. It would be producing rare earth elements and potentially making a significant difference in the Department of Defense's demand."

Written by Patrick C. Miller



NEW LOOK SAME CEM

This fall, select hallways and study areas were enhanced to reflect our pride in UND and engineering. Directional signage was added to hallways, helping visitors and new students navigate through our five connected buildings. The first phase included the areas that receive the most prospective student traffic.





Surojit Gupta, associate professor in the Department of Mechanical Engineering, shows some of the raw materials and products used and produced in the Materials Science Lab in UND's College of Engineering & Mines. Photo by Patrick C. Miller/UND Today.

UND LAB MAKES STERNER STUFF

Students get hands-on research experience in Materials Science Lab

Surojit Gupta, a UND mechanical engineering associate professor, hands a visitor a small block of what appears to be shiny plastic. But it's too heavy for plastic and too light for metal. What is it?

"If we had the same thing made out of steel, it would be twice as heavy," he noted. "This is a very lightweight material. If you look at the luster, it has a metal-like appearance, but it's not metal. It's ceramic."

Gupta explained that the material has the advantage of ceramics in that it can withstand high temperatures without melting – as metals tend to do – while remaining pliable like metal without becoming brittle – as ceramics tend to do. In the field of materials science in which Gupta specializes, it's known as a MAB-phase material. For example, molybdenum, aluminum and boron reacts at high temperatures to form MoAlB, which is a type of MAB phase.

"These are the reasons the U.S. Army and NASA are very interested in this particular class of materials," Gupta said. "They have high-fracture toughness and can be used for different types of demanding applications, like turbines, coatings and gear-based applications where you need less oil to function."

High-tech materials

Gupta runs the Materials Science Lab in the College of Engineering & Mines in which students – ranging from undergraduates to Ph.D. candidates – in the advanced materials and manufacturing group engage in fundamental research funded by the North Dakota Department of Agriculture, NASA EPSCoR and North Dakota Corn Council. In addition, there are joint agreements for ongoing collaborations with the U.S. Army Research Lab and the NASA Langley Research Center.

Mackenzie Short, a UND mechanical engineering graduate from Grand Forks, ND, who's been accepted into the CEM master's program, and Daniel Trieff, a senior from Chaska, MN, spent their summer working remotely on an internship with the NASA Langley Research Center in Hampton, VA. They're studying MAB-phase coatings for metals that will make NASA vehicles used for deep-space exploration more resistant to radiation, abrasion and corrosion.

"It's a new material we're making ourselves," Short said. "We have to mix it up and press it so that the individual particles are closer together. That way, they actually interact under heat and become a MAB-phase metal."

The pair is awaiting test results, but is encouraged by what they've discovered so far. They're using a microencapsulation process that reduces the individual particles down to 44 micrometers or .0017 of an

inch – the size of a dust particle. A polymer similar to that used for 3D printing is applied to the ceramic particles to a metal surface.

"We're going to be testing how wear-resistant it really is," Short said. "The idea is to prolong the life of any equipment we send into space by having a wear-resistant and abrasion-resistant coating."

Trieff said being involved in a NASA research project is beneficial to his educational goals.

"It's definitely a pivotal turning point for my career," he said. "It should help me get into grad school. I couldn't be more thrilled."

To the moon

Maharshi Dey, a Ph.D. candidate from India, is also working in Gupta's materials science lab to develop high-temperature ceramics for NASA that could be used for missions to the moon, Mars or Venus.

"The biggest problem with ceramics is that they can go up to really high temperatures, but they're brittle, which means they would not be used for any applications where you need it to be foldable or stretched," he explained. "You can use metals, but they can't go up to a high temperature because they have low melting points."

Dey is studying layered ceramics that he compares to cards in a deck. A single card is easily folded, but layers of cards create far greater strength with the ability to bend without breaking.

"You get the best of metals, as well as the high temperature aspects of ceramics," he explained. "It is also strong compared to many other ceramics. We're making some new types of ceramics that haven't been discovered."

Tribology – the study of friction and wear on materials – is the area of specialization for Caleb Matzke, a master's degree student from Hastings, MN.

"Think of it as the rubber on the sole of your shoe," he said. "I study the characteristics of how much it wears down over time, except I'm doing it with polymers and bearing steels."

Matzke has been working on a project for the U.S. Army the past two years involving polymers with ceramic additives and how they wear under dry conditions or when exposed to different fuels in pump systems.

"What we've noticed in these different steels with the ceramic powders is that they have a very high hardness," he stated. "Any sort application, such as in the auto industry, you could use these where there's excessive wear and tear – where the need for high hardness comes into play. It's a standard steel with a small amount of ceramic additive, so there's very little change in weight."

Ag products benefit North Dakota

The lab's research not only benefits federal agencies looking for solutions to complex technical challenges, but can also help North Dakota's agriculture industry by finding beneficial uses for corn byproducts that are often treated as waste. Gupta points out that this could help farmers deal with wide price fluctuations in agricultural products.

"If we can make wonderful materials out of ag-based products, then we can help our farmers," he said. "If we can add value to the products, it will give our farmers an additional revenue stream so they can sell what they're now burning or throwing away. Another one of our goals is to make the ag industry more profitable."

The potential of using corn-based products to create materials for the biomedical engineering field is being explored by Erica Eades, a temporary research assistant from East Grand Forks, MN, who received her master's degree last spring, and Sabah Javaid, a Ph.D. student from Pakistan. They're studying an idea for bone tissue engineering using corn-derived materials and plastics to help heal bone injuries.

"If you get a fracture within your body, you could potentially utilize this to fill the void," Eades explained. "It provides support to the area and stimulates the body's natural healing process. It can help reduce the number of surgeries."

Negin Ziamahmoodi is a senior from Iran majoring in mechanical engineering with a focus on material science. She originally came to UND as an aviation student, but after taking a course Gupta taught, she switched majors. During the summer, she worked in the materials science lab on a project using hemp and lignin from corn to filter water, but has been involved in other research projects as well.

Giving students his best

"It's a very busy lab and I absolutely love it," she said. "I'm learning to work with a lot of different materials. It's a broad view on materials science, which I really appreciate."

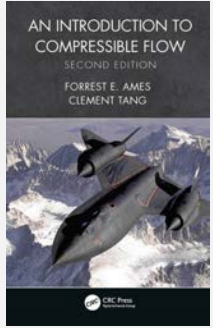
Gupta said that when students discover their passion for research, it underscores the rewards of teaching. He referenced a note and photo he received from a former student who recently completed his Ph.D. and accepted a job in industry.

"I like to tell my students science doesn't sleep," he said. "That's what inspired this student to pursue his Ph.D. and then turn professional."

"It's difficult to do teaching and research, but when you get a message like this, it inspires you to go out of your way to help students," he continued. "That's what we are here for – to help our students attain their goals and ambitions – and give them the best we can."

Written by Patrick C. Miller

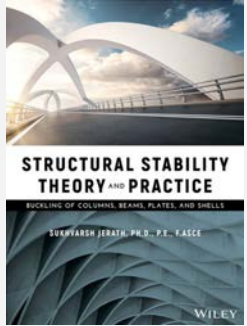
RECENTLY PUBLISHED FACULTY BOOKS



An Introduction to Compressible Flow

Forrest E. Ames & Clement Tang

An Introduction to Compressible Flow, Second Edition covers the material typical of a single-semester course in compressible flow. The book begins with a brief review of thermodynamics and control volume fluid dynamics, then proceeds to cover isentropic flow, normal shock waves, shock tubes, oblique shock waves, Prandtl-Meyer expansion fans, Fanno-line flow, Rayleigh-line flow, and conical shock waves.



Structural Stability Theory and Practice: Buckling of Columns, Beams, Plates, and Shells

Sukhvarsh Jerath

Ideal for practicing professionals in civil, mechanical, and aerospace engineering, as well as upper-level undergraduates and graduate students in structural engineering courses, this book provides readers with detailed mathematical derivations along with thorough explanations and practical examples.

MACHINE LEARNING AT UND PUMPS UP NORTH DAKOTA'S OIL PRODUCTION

From drill bit to pipeline, the Big Data work of Assistant Professor Minou Rabiei matters for N.D.'s oil and gas industry

As she works with algorithms on her computer at UND, Minou Rabiei exerts a few ounces of pressure with every keystroke. That's where the miracle of leveraging begins.

For Rabiei is an assistant professor of petroleum engineering. And because she uses Big Data to figure out how to squeeze more oil out of North Dakota's Bakken formation, Rabiei's keyboard is one of the world's strongest amplifiers, turning her keystrokes into the practical equivalent of kilotons of additional force.

Big Data matters in oil and gas, because the industry is comprised of so many disciplines and complex operations. Those disciplines span the entire process of resource recovery and refinement, from the geological exploration of oil and gas reserves to delivering fuel to consumers.

Each of these areas yields millions of data points every day, said Rabiei, and that number is only growing as technology advances. In the UND College of Engineering and Mines, Rabiei is one of many professors trying to rein in and harness that data to increase extraction.

Rabiei's own specialty in processing all of that data is machine learning and artificial

intelligence. She's bringing those skills to bear on a complex industry where a 1 percent increase in recovery could result in potentially billions of dollars in new revenue.

Rabiei's idea is that if well-trained algorithms – complex computation sets – can enhance the resource-extraction process in real time, they can also bolster safety and regulatory compliance, all of which could create better earnings for the industry. And that, in turn, would mean increased revenue for North Dakota's economy.

"Every industry is faced with a huge amount of data, and learning and gaining the capacity to use this data provides a huge competitive advantage," Rabiei said. "So, the more advanced and optimized the operations are in the oil and gas industry, the more advantage we can provide to the economy as a whole."

Decisions informed by data

To illustrate machine learning's effectiveness, Rabiei described the responsibility of a drilling engineer to pick the best-suited drill bit for a new operation. In many cases, a producing company brings in another service provider to start drilling a well – a highly specialized task.

"Traditionally, picking the optimal drill bit is the task of an experienced drilling engineer who, based on previous knowledge from different formations they've worked with, knows the type of rock and the issues they might encounter," Rabiei said.

But sometimes such a level of knowledge or experience isn't available. What Rabiei researches is the ability of an algorithm to perform the same task, using massive amounts of previously collected data from drill sites.

"If a new engineer, for example, wants to design an operation in a new formation, he or she can use previous knowledge accumulated in a knowledgebase and integrate different parameters," she continued. "There are so many factors that need to be considered when finding the best type of drill bit."

Using such a knowledgebase, an algorithm brings all of the available information – current and previous – together to suggest the best type of bit to use. Rabiei said such an algorithm can use that data to help identify, and even predict, potential defects and drilling issues that might be encountered in the operation. (When it comes to the 24/7 process of mining, any stoppages or delays contribute to losses on the entire effort.)

What's great about today's technology is the fact that data from the drilling – such as the pressures, temperatures and fluid characteristics of the earth being bypassed – can be gathered in real time, she said. That data can then be fed into an algorithm, also in real time.

As North Dakota sits atop some of the largest reserves of oil-bearing shale in the world, any amount of increased extraction from the unconventional rock can have major economic implications.

"If drill operators can be proactive in terms of predicting problem areas in the formation, before reaching that location, they could be able to change the speed of drilling, or they could change the characteristic of drilling mud," Rabiei said. "That saves a lot of money for both the producing company and the drilling service provider."

Well-equipped for research

At UND's College of Engineering and Mines, 10 existing labs in the Department of Petroleum Engineering include two drilling simulators, a multiphase flow and pipeline simulation lab and a virtual reality lab containing myriad scenarios.

Soon, UND will also operate the world's largest full-scale oil drilling and completion lab. The lab's impressive capabilities to replicate a real rig site will enable Rabiei to refine her machine learning processes in previously impractical ways.

"What we will soon be able to do is repeat different experiments in terms of drilling a type of rock from a certain formation," Rabiei said. By testing samples from an area they're examining (such as from the Williston Basin), researchers can acquire all of the properties and characteristics of the rock. The lab can also recreate conditions deep within the earth that a drill would encounter, which makes the data all the more valuable.

The repeatability of the "simulated" drilling processes is key to building inputs for Rabiei's machine learning algorithms.

It's similar to seeing a doctor, Rabiei said. You have symptoms, and you explain those symptoms to the doctor. Then the doctor, based on his or her experience and previously seen cases, can tell you what type of illness or ailment you're likely experiencing.

Replace the doctor with an AI-capable computer, and you'll see how the process works in petroleum engineering. And for

Rabiei, training algorithms to maintain high levels of accuracy in their "diagnoses" is a crucial aspect of her work.

"That's basically the same thing we are doing, in terms of predicting possible issues during drilling operations," said Rabiei of her medical analogy.

Work of heightened importance

North Dakota is home to one of the world's largest reserves of oil-bearing shale. Extraction from such a rock formation is known in the industry as "unconventional," which essentially means it's hard to economically recover the vast amount of oil and gas that's present.

Considering all of the North Dakota shale oil that is known, only around 8 percent reaches that "economical" threshold. More could be recovered, but right now, the cost of doing so would exceed the oil's value.

"Any technology or any type of analysis that tells us how to gain even a fraction of a percentage from that remaining 92 percent is huge, in terms of volume and profit," said Vamegh Rasouli, Continental Resources Distinguished Professor and chair of UND's Department of Petroleum Engineering.

That's why the industry leaders are turning to UND for its energy research capabilities, both in the College of Engineering and Mines as well as the Energy & Environmental Research Center just east of UND's main campus.

Through the support of the North Dakota Industrial Commission (NDIC) and North Dakota's Oil & Gas Research Council, department faculty have the ability to fund Ph.D. students and additional research projects, many of which also involve machine learning and artificial intelligence. That research effort, in turn, directly impacts the state's energy industry.

In March, the state committed to an additional three years of funding. That financial support also supported the establishment of the new drilling and completion lab.

Brent Brannan, director of the NDIC Oil and Gas Research Program, said UND continues to evolve as a leading research institution through the Department of Petroleum Engineering's work, as well as its contributions to the state's oil and gas industry.

"Partnerships between public and private entities provide a direct benefit towards the advancement of energy development in North Dakota," Brannan told UND Today. "The innovative teaching and support for undergraduate students results in excellent job placements, while the establishment of the Ph.D. and Master's programs have successfully contributed to numerous publications, presentations, and applied research activities."

Said Rasouli, "this support has been a great assistance to us in terms of increasing our number of Ph.D. students, as well as our research profile. The NDIC's heavy interest in data-driven solutions indicates the importance of this research area, in terms of the needs of North Dakota."

Thus, Rabiei's research area carries great importance, especially considering that UND has a Grand Challenges goal committed to the harnessing of Big Data, said Rasouli.

"Dr. Rabiei's research is key to the department, to the College, as well as the University, because it contributes to a number of UND efforts," he continued. "The statewide interest in her expertise only heightens that importance."

Written by Connor Murphy



\$450,000 TO HELP SCHOOL TEACHERS TEACH ENGINEERING

National Science Foundation grant will pair school teachers and UND researchers to design engineering tasks

UND researchers are part of a project, funded by a three-year, \$450,000 grant from the National Science Foundation, to help North Dakota elementary and middle school teachers design and implement engineering tasks in the classroom that are culturally relevant for American Indian and rural students.

The project is in partnership with the Northeast Education Services Cooperative.

Project ExCEED (Exploring Culturally relevant Engineering Education Design) will include teachers from the Devils Lake, Mount Pleasant-Rolla and Rolette school districts. They will take part in hands-on summer workshops to get experience and understanding of the engineering design process, culturally relevant instruction methods, and learn to incorporate both into their classrooms, whether they are teaching science and math or English and history. Workshops were held in summer 2021.

“Engineering design is problem-solving, and an essential part of that is considering the culture and needs of the people involved,” said Frank Bowman, associate professor and chair of UND chemical engineering and one of the grant collaborators. “This project will prepare teachers to share the excitement of engineering problem-solving through design tasks that are directly relevant to the students in their classrooms. We are thrilled to be working with our community and school partners to better support Native American and rural students here in North Dakota.”

During the school year, and with guidance from the project team, teachers will develop lesson plans for engineering design tasks tailored to their classrooms, curriculum requirements and community culture. Cultural relevancy is a key focus of the project. The classroom engineering tasks, especially those developed to be specifically relevant to Native American and rural student populations, will be promoted and made available to other teachers across the state and nation.

The goal is for teachers to create engineering design tasks and use teaching practices that are relevant to and support students across a breadth of cultural communities and groups, with a special focus on Native American tribes.

Throughout the project, the research team will study the effectiveness of the professional development program. As the initial cohort of teachers become more comfortable with the skills they are learning, they will take on a mentorship role, guiding a second group of teachers through the program in the following year. A key goal of the project is to foster a collaborative network of teachers within and across school districts that can continue to support one another.

UND researchers taking part in the project include Bowman; Julie Robinson, assistant professor of teaching & leadership, and Bethany Klemetsrud, assistant professor of chemical engineering. The project team also includes Erin Lacina, director of professional learning and operations at the Northeast Education Services Cooperative, one of seven regional education associations in North Dakota.

Written by Jan Orvik

GOODBYE, GUTENBERG:

UND PROFESSOR PUBLISHES PIONEERING ONLINE TEXTBOOK

Besides several books and numerous papers, Dexter Perkins, professor of geology and geological engineering at the University of North Dakota, has penned three editions of his Mineralogy textbook. When he last approached Pearson, the large publishing house that had produced the textbook in the past, for another update, he faced a rejection. Small-volume textbooks were being discontinued.

So, Perkins took a different approach – one that seems to align with the increasingly virtual nature of higher education.

Perkins wrote and published a free, online-based textbook, which bears the same title, Mineralogy. It is the de-facto fourth edition of his print book that serves as an introduction to the study of minerals.

“With an online book, you can put in many, many, many more full-color photographs and line drawings,” Perkins said. “You can put videos in there. You can put links to other web pages, three dimensional models. You just can’t do this in a print book.”

More than an online academic text, accompanied by much better visuals than what is possible on paper, the book is the latest effort at UND to promote and introduce open educational resources in the classroom. Under the leadership of Dean of Libraries & Educational Resources Stephanie Walker, the Chester Fritz Library has amassed a collection of online, free-to-use textbooks and other materials, which collectively have saved UND students millions of dollars in textbook costs in the last several years.

“I wanted a good resource that would support an online class,” Perkins said. “When students come to my classroom, and I’m talking to them, and we’re all there together, it’s one thing. But, if they’re learning independently, and they live halfway around the world, you really have to have good stuff to support that.”



LEARN MORE

Scan with your phone’s camera app to read more about Perkins’ new book.



UND BECOMES FIRST UNIVERSITY IN NEW U.S. SPACE FORCE PROGRAM

Gen. John Raymond and UND President Andrew Armacost sign historic agreement

With a signing of documents, a shake of hands and an exchange of salutes, Gen. John W. “Jay” Raymond and UND President Andrew Armacost on Aug. 9 made the University of North Dakota the first member of the new U.S. Space Force University Partnership Program (UPP).

Raymond, Chief of Space Operations, and Armacost, a retired U.S. Air Force brigadier general, inked a memorandum of understanding (MOU) between their organizations that opens the door for opportunities in research and workforce development. The signing of the historic agreement was held in Robin Hall at the John D. Odegard School of Aerospace Sciences, which was attended by government representatives, business leaders, military personnel and UND leadership.

Universities were selected based on four criteria: the quality of STEM (science, technology, engineering and mathematics) degree offerings and space-related research laboratories and initiatives; a robust ROTC program; a diverse student population; and degrees and programming designed to support military, veterans and their families in pursuing higher education.

“When I see the four goals of this program – research and workforce development; collaborating in research with other universities; establishing educational opportunities for students and ROTC cadets; and developing diverse, STEM-capable graduates for the Space Force – I can say with confidence that UND is well positioned for all of them,” Armacost said.

Drawing a line in space

Raymond stressed the importance of the Space Force mission, noting that many aspects of the U.S. economy and communications are dependent on satellite technology. However, while space operations have largely been benign to this

point, he said America’s adversaries have been developing capabilities to attack its space assets. Raymond explained that although nations have developed policies for encounters on land, in the air and at sea, this has yet to occur in space.

Raymond noted that it was almost exactly 35 years ago to the day that he showed up for his first assignment as a second lieutenant at the Grand Forks Air Force Base. He married a UND graduate and urged faculty members not to forget the roles they play in shaping young lives.

Present at the ceremony were North Dakota’s two U.S. Senators – John Hoeven and Kevin Cramer – and Janna Ness, representing U.S. Congressman Kelly Armstrong. Armacost thanked the state’s congressional delegation for their support of UND’s space and national defense initiatives.

Attracting industry development

Cramer stressed that the Space Force program creates opportunities that extend beyond research and workforce development, including potentially attracting industry development.

Armacost also recognized state senators Ray Holmberg and Curt Kreun of Grand Forks, noting that the North Dakota Legislature had approved \$4 million in funding for UND space-related research activities.

During a roundtable discussion, Raymond was also briefed on UND’s plans to invest \$9 million over six years to expand the University’s strengths to pursue projects with federal agencies, including the Department of Defense and Department of Homeland Security. John Mihelich, vice president for research and economic development; Robert Kraus, dean of aerospace; Ryan Adams, chair of the School of Electrical Engineering & Computer Science; and Brad Rundquist, dean of the College of Arts & Sciences discussed efforts to hire new faculty and build infrastructure for the strategic R&D initiative.

Space Force’s rapid expansion

Armacost pointed out that when Raymond first visited UND in January 2020 as commander of the newly created U.S. Space Force, he was the unit’s only member. Now, it has more than 5,400 active-duty Guardians – as they’re known – and perhaps as many civilians. The numbers are expected to keep growing at a rate of hundreds more annually.

“The Space Force faces some of the toughest challenges in engineering, science, and technology,” said Raymond. “Space is hard. We need our nation’s brightest minds working to help us tackle these problems.

“That is why we have established the University Partnership Program to harness the innovation at universities across our country,” he continued. “Today, I’m excited to welcome the University of North Dakota as our first official UPP member, with ten more schools to follow in the coming months.”

Written by Patrick C. Miller (Excerpt)



Photo courtesy of Minnkota Power Cooperative

PROTECTING THE POWER SUPPLY



UND research aims to defend U.S. electrical grid against cyberattacks

A cyberattack aimed at taking down America’s electric power grid and bringing the country to standstill isn’t a hypothetical scenario in the mind of Jun Liu, associate professor in UND’s School of Electrical Engineering & Computer Science.

It’s already happened, although not in the U.S. In December 2015, hackers in Ukraine attacked the country’s electrical grid and succeeded in denying power to more than 200,000 customers.

Liu and a team of UND researchers want to prevent this from happening in the United States. They’re just over a year into a three-year, \$400,000 research project funded by the U.S. Department of Energy (DOE) to explore the idea of using blockchain technology to safeguard fossil fuel-powered generation systems.

“We’re developing a security protection mechanism with the ability to detect networked devices that have been hijacked,” Liu said. “The major difference in our research is that we do not assume any entity in the network can automatically be trusted.”

If the UND research team is successful, Liu said the technology could be applied to all forms of energy generation, which is one reason why DOE is interested in it. To test the concept, UND is partnering with Minnkota Power Cooperative – based in Grand Forks, N.D. – operator of the coal-fired Milton R. Young Power Station near Center, N.D.

Other applications

Dan Inman, Minnkota’s vice president and chief information security officer, is a UND engineering graduate and a member of the College of Engineering & Mines Executive Board. He sees potential for Liu’s cybersecurity system beyond the energy industry.

“If we could make it happen in a way that it’s economical for utilities, then it could be a great tool, not only for utilities, but also for others in the industrial control systems (ICS) field to help ensure the data they’re getting and controlling is accurate and correct.”

According to Inman, most current utility ICS have one main computer system networked with many different pieces of equipment to monitor, control or perform functions in the field, such as the hundreds of substations in Minnkota’s transmission system.

“If you go after that one computer system, or provide false data to that system, you could have the ability to take out various ICS systems, and that’s exactly what happened with the Ukraine event,” he said. “It really got us thinking about what we can do to help mitigate some of our security concerns.”

Conventional security systems, Liu explained, often rely on a baseline of trust, an assumption that some devices in a network are so secure that any data or information they provide is automatically accepted as accurate. But if the device has been successfully hacked – as was the case in the Ukrainian situation – then relying on corrupted data can have disastrous consequences.

Any device can be hacked

“Nobody can be 100 percent certain that a device hasn’t been hacked,” Liu said. “In our research, we simply don’t allow a device to be trusted by default. Instead, we assume that any device can be hacked.”

That’s where blockchain technology comes in. Blockchain has become well known in the realm of cryptocurrency, such as Bitcoin, by eliminating the need for banks and financial middlemen. The blockchain solution “chains” together “blocks” of transactions in chronological order to thwart unilateral changes on past transactions.

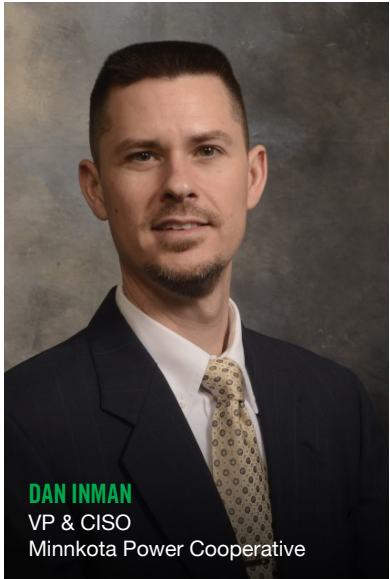
“We rely on consensus, which means we assume the number of compromised or hijacked devices is small because it’s not easy for an attacker to gain control of many networked nodes at the same time,” Liu said. “To cause damage after gaining control, the attacker issues an incorrect control command to mislead or change the direction of the data exchange in the network or to modify the original data.”

But if the behavior of a networked device deviates from the consensus reached among other networked devices, the device is considered untrustworthy and isolated to prevent it from causing potential damage.

“The consensus describes the expected control actions specified by the operator, and all the nodes should abide by that specification,” Liu said. “A hijacked node’s behavior will be different from the expected behaviors in the specification. Blockchain technology is a method of trying to identify those differences.”



DR. JUN LIU
Associate Professor, SEECs



DAN INMAN
VP & CISO
Minnkota Power Cooperative

Liu emphasized that employing blockchain technology in a cybersecurity application is far more difficult than simply installing open-source software. One component of the security system he’s developing is an algorithm to identify deviations from consensus, but that alone isn’t enough.

Software-defined networking

“We employ a new technology called software-defined networking,” Liu explained. “There is no physical rewiring required with this technology, which means communications can be changed dynamically inside the network. After any abnormal devices are detected, the operator or an automatic controller can immediately issue the commands to isolate devices and take them out of the system.”

Inman admitted he was skeptical at first about the feasibility of incorporating blockchain technology into an economical cybersecurity system in an ICS environment, but he’s been impressed with some of the early demonstrations he’s seen.

“In a simulation, they’ve been able to reproduce how the information being shared amongst the sensors is validated,” he said. “They’re focusing on validating information from field devices to travel up to the computer level and how all those nodes will talk to each other.”

Liu said one goal of the DOE research project is to develop a testbed enabling users to test prototypes of their networks using the blockchain cybersecurity system.

“We’ve spent a year constructing a simulated environment to gain a feel for how things will look before doing a larger experiment,” he noted. “We have already constructed a cloud-based infrastructure, which has the benefit of being easy to access and the ability to easily scale up.”

UND advances cybersecurity field

Inman said the project is indicative of the major advancements UND has made in the cybersecurity realm, including helping industry meet the demand of filling positions for professionals in the field.

“In 10 years, we could be around 4 million people short of what’s needed to fill all the different cybersecurity positions,” he said. “The College of Engineering has created a well-rounded cybersecurity program for students interested in this evolving field and brought in professionals with real-world experience to help ensure the skills obtained while attending college translate into the skills industry so desperately needs.

“It’s fantastic, because an individual coming out of UND is going to be in a better position with a degree in the cybersecurity space, and have tremendous opportunities,” Inman added.

Others involved in the UND research project include Mike Mann, Associate Dean for Research, and Hossein Salehfar, professor in the College of Engineering & Mines.

Written by Patrick C. Miller



ENGINEERS WITHOUT BORDERS CONSTRUCTION IN GUATEMALA COMPLETE

The UND Engineers Without Borders organization is excited to announce the completion of construction on EWB-UND’s Pambon Springs Project! After more than two years of planning, design, and implementation, the students of EWB-UND are ready to move into the monitoring and evaluation phase of their project. This coming year, they are planning to send another group of students (and a PE) to Guatemala to review the construction and test the water system.



UND PARTNERS WITH COLLEGES
ACROSS THE STATE & NATION TO
**HELP STUDENTS GAIN
ENGINEERING DEGREES**

**CEM’s collaborative programs
open opportunities for students
from other colleges**

Students from all over the world come to UND for premiere engineering education, but even more will be coming from other colleges. Thanks to agreements between institutions like Marymount University, Bismarck State College, and Williston State College, students now have a guided path to gaining an engineering degree from UND while starting their education elsewhere.

Dual Degree Program

Marymount University has partnered with the University of North Dakota and created a dual degree pathway to earn an ABET-accredited engineering degree at UND while fulfilling degree requirements at MU. Students have the opportunity to attend UND classes virtually while residing on MU’s campus. Mapped-out course plans ensure the timely completion of the dual degree pathway.

MU and UND have created this partnership to remove barriers students may face when

obtaining two degrees. Course credits are shared between the institutions so that a single course may cover multiple requirements. UND courses are delivered online year-round, allowing students to gain hands-on experience at UND’s state-of-the-art laboratory facilities during the summer labs.

2+2 Program

After two years at Bismarck State College or Williston State College, the 2+2 Program allows students who have earned their Associate in Science degree the opportunity to obtain a Bachelor of Science degree in chemical, civil, electrical, mechanical, or petroleum engineering at the University of North Dakota in approximately two years. The program can be completed on-campus or online through the Distance Engineering Program in two years, meaning students can complete their coursework remotely.

In just two years, BSC and WSC students with an Associate in Science degree can get their Bachelor of Science degree from UND. According to the U.S. Bureau of Labor Statistics, engineers have a median annual

wage of \$91,010, and the engineering field projects to have employment growth of nearly 140,000 new jobs over the next decade.

Great Benefits for Students

With these programs, students can acquire the skills and knowledge to contribute to a multifaceted workforce. Throughout their education, students will receive:

- A grounding in liberal arts from MU, BSC, or WSC with a focus on courses in the humanities, chemistry, physics, and mathematics
- Knowledge about ethics, safety, communications, and other skills necessary to pursue a career in engineering
- A firm understanding of the issues affecting the industry, including science and technology, economics and business, policy and regulation, and society and behavior.



**WELCOME (BACK)
SCOTT KOROM!**

Professor, Director of Western North Dakota Operations

On June 30, 2021, Scott began serving as a Professor of Engineering and now leads our efforts in Western North Dakota. Scott supports our partnership with Bismarck State College and is responsible for outreach and recruiting activities with high schools and colleges in the western part of the state. He is also helping facilitate student and faculty projects with industry, strengthening our relationship with state agencies. Scott served as a faculty member in GGE for twenty years before joining Barr Engineering in Bismarck in 2014. While at Barr, he worked closely with numerous North Dakota industry partners in the power, fuels, mining, agricultural, and public sectors.

Want to learn more? Contact Scott at 701.777.6327 or scott.korom@UND.edu



**UND’s departments of Surgery
and Computer Science team up
to explore augmented reality
technology in the operating room**

“It’s not like changing the alternator in your car where you can easily reference the repair manual or a technical read-out in the moment,” explained Dr. Stefan Johnson of teaching surgery to medical students and residents. “We’re still teaching with a mentor and pointing out things with a forceps or surgical instrument and saying ‘cut here’ or ‘watch me do this and then you repeat the maneuver.”

Laparoscopy and robotics notwithstanding, this is how surgical training has been done for centuries, said Johnson.

Thanks to a partnership between the UND’s School of Medicine & Health Sciences (SMHS) Department of Surgery and the School of Electrical Engineering and Computer Sciences (SEECs) within the UND College of Engineering and Mines, though, this age-old method of surgical education is getting an update.

Over the past eighteen months, faculty from the two UND teams have been helping the Surgery Residency Program that Johnson directs experiment with augmented reality (AR) technology in the surgical suite.

Not quite virtual reality, the AR concept uses enhanced glasses that allow for supplemental images or videos to overlay what the physician sees in the operating room (OR). These images or videos can be anything, Johnson said, from radiological images like X-rays or CT scans to patients’ vital signs, instructional videos, and even pages from the surgery textbook, all passed in front of surgeons’ field of vision.

UND leading the world

“So, in the old days, residents would essentially practice on cadavers and patients—they didn’t have much choice,” continued Johnson, who explained that where patient safety is concerned, the real OR is hardly the place for cumbersome, and potentially unclean, medical gear, textbooks,

or video monitors. “But this technology has potential to bring better knowledge into the education environment, and for clinical use in general, safely.”

The AR glasses concept was developed by former SMHS clinical professor of surgery Mark Jensen, M.D., who helped UND secure a \$20,000 National Institutes of Health SHARPhub grant to study the concept. Although he retired before the grant period ended, Jensen said the fact that nothing has, to date, been published in the medical literature on AR in the surgical suite means UND has an opportunity to be a world-leader.

Enter Ron Marsh, Ph.D., professor in the SEECs who knows Jensen from their mutual interest in ham radio and asked Jensen how his team could help.

“I have a student doing research in virtual reality,” said Marsh whose team is handling the software side of the project. “We looked at some of the different glasses and settled on the set that we’re using now. Then, we were in contact with the manufacturer and discovered that they had developed a Zoom application that works on these glasses. The Zoom capability gives us everything we want, so we basically we took over figuring out how you get the AR part to work from the technical standpoint.”

If the software and wireless connectivity issues can be ironed out, said Marsh, this relatively inexpensive technology – \$500 per pair of glasses – could radically improve the practice of not only clinical surgery but rural medicine.

“Let’s say you’re a doctor in Cando, which means you’re maybe not a trauma surgeon,” Marsh mused. “And somebody’s brought in who’s critically injured. Now Cando is pretty rural. If they have a pair of these glasses, and the trauma center in Fargo has a pair of glasses, with Zoom in these glasses the two providers can connect and the doc in Cando can look down at the patient – there’s a camera in the glasses – and the surgeon in Fargo could literally see what his colleagues see.”

Lifesaving technology

In effect, said Marsh, the “active” space on the AR lenses would allow the surgeon in Fargo to advise the physician in Cando by writing or mapping out, with a stylus, instructions on the Cando physician’s field of vision in real-time – cut here, suture there – from Fargo.

“If you’re in the military or maybe with first responders in rural areas, it gives you a truly interactive telemedicine for these emergency surgery situations,” said Marsh. “This should be really exciting, because in traumatic situations I think this could save lives.”

Before such technology is deployed in the field, though, Johnson said that his vision is to get to a point where preceptors can provide such real-time instructions and feedback to learners through the glasses in the educational setting.

“It’s wide open,” Johnson continued. “You could do this in the anatomy lab, maybe put images from the surgery textbook into the glasses as students practice these operations on cadavers. You couldn’t do that in a sterile OR. We can call up any image we want in the glasses.”

And with UND leading the way, operating rooms across the region may be able to do just that.

“We now have capabilities of creating 3D reconstructions of imaging from CT scans that detail anatomical relationships of blood vessels and the location of tumors,” added Dr. Sabha Ganai, an associate professor of surgery for the SMHS who specializes in surgical oncology, hepatobiliary surgery, and endocrine surgery at Sanford Health in Fargo, N.D. “What is nice about AR glasses is it allows us the ability to superimpose the visualization of prior imaging and real time ultrasounds to help guide doing complex therapies like microwave ablations. We currently have to turn our head while we are working, but the future is an integration of our actions with what we see ahead of us.”

Written by Brian James Schill



UND NABS \$5M CONTRACT TO DEVELOP AUGMENTED REALITY TECH FOR U.S. ARMY

UND and its research partners have been awarded a \$5 million contract from the U.S. Department of Defense to develop augmented reality technology for U.S. Army vehicles.

The university, along with AM General and ARA, will be developing technology that will allow soldiers operating or riding in Humvees to see battlefield data visually represented as an AR heads-up display on the windshield, UND said in a press release.

This involves determining the best methods for collecting available battlefield data, maintaining its security and displaying it in a manner that provides full battlefield situational awareness.

“The goal is that when the operator looks through the windscreen, he or she will see an augmented view of the world,” said Jeremiah Neubert, professor of mechanical engineering at UND and principal investigator on the Humvee project. “The operator will be able to see road edges, buildings, obstacles, people and so on. So operators can drive without lights at night, if they have to, or through dust storms or fog.”

Neubert said this work will put UND “right at the cutting edge of Heads-Up Display technology.”

“There will be no one with any more advanced technology than we’ll have, as this project proceeds,” he said.

Mark Askelson, executive director of UND’s Research Institute for Autonomous Systems, noted that autonomy is one of UND’s grand challenges.

“We’re proud to have pioneered the development of autonomous technology in

aircraft, and we’re thrilled to now be doing the same in ground vehicles,” Askelson said.

Askelson said he’s excited to bring UND’s work to help the nation’s defense department.

“We can solve these very real problems that are affecting people in the field,” he said. “We can help the operators execute their missions with greater safety and more efficiency. And that gets all of us pumped up.”

Sen. John Hoeven, R-N.D., said the technology is “critical support” for service members that will provide them with “better awareness to counter threats and succeed in their missions.”

“This project will help develop new systems for providing important data to our soldiers in their vehicles on the battlefield,” Sen. John Hoeven, R-N.D., said in a news release. “At the same time, this is an important opportunity to continue building UND’s research expertise and is part of our efforts to secure additional investment in our state’s tech industry, ensuring this sector continues serving as the third wave in North Dakota’s economic growth.”

Earlier this year, UND accepted delivery of a Humvee from AM General, the vehicle’s manufacturer. That Humvee now is housed in the Tech Accelerator Building on the western edge of campus, according to the UND news release.

Once UND researchers develop and install autonomous systems technology on the vehicle, extensive testing is likely to take place at AM General’s Proving Grounds and Testing Center, a 300-acre facility in South Bend, Ind.

Applied Research Associates (ARA), UND’s other research partner on the project, is an Albuquerque, N.M.-based company that offers science and engineering research on problems of national importance.

The project will involve different aspects of campus, including the engineering and aerospace schools, as well as the College of Arts and Sciences and RIAS.

The psychology department will be conducting human-factors research, analyzing such elements as Humvee operators’ eye movements, attention span and cognitive load.

“We want to make sure the Augmented Reality technology is not intrusive,” Neubert said. “We don’t want the technology to make people confused, in other words. It has to be something that’s really easy to pick up on, and that actually makes it easier for the operators to do their jobs.”

Written by Sydney Mook



A LOVING HAND

UND student engineers use microcontrollers, 3D-printed parts to create biomechanical prosthetic for local man

Last fall, UND senior Sam Dressler was at a picnic for engineering majors in University Park when Megan Larson, a fellow engineering student, ran up to him. “Say, I heard you don’t have a senior project yet,” Larson said. “Do you want to join our group?”

Not sure, Dressler answered. What’s the group going to do?

“Well, we know someone who needs a biomechanical hand,” said Larson. “We’re going to build him one.”

And so they did.

For their capstone project to top off their undergraduate careers, Larson, Dressler and three other seniors at UND built a functioning, prosthetic partial hand. Designed for a local man who had lost the ring and pinky fingers on his left hand, the device features prosthetic versions of those two fingers attached to a forearm sleeve.

Inside the sleeve are sensors that rest on the man’s forearm. The sensors detect and respond to the muscles that normally would control the man’s ring and pinky fingers. So, when the man moves those muscles, he moves his new fingers, too.

First of its kind

“We believe this prosthetic is the first of its kind, because it’s a noninvasive solution for a partial hand and is customizable to the amputation,” said Larson, the project’s student leader and an Electrical Engineering major/Biomedical Engineering minor at UND. In other words, the prosthetic relies on sensors that sit on the surface of the skin, rather than using electrodes implanted in the muscles of the arm.

“In addition, we designed it so it can be adapted for any amputation,” she said. “So if someone has different fingers that are missing, you can make a device for that portion of the hand, and put the sensors on a different location on the forearm. Then you’ll have a whole new prosthetic for that new case.”

The students’ skill and the care with which they’d crafted the device were obvious from the moment he tried the prosthetic on, said the subject, who wishes to remain anonymous.

“Then the moment of truth – trying to move the fingers,” he said.

“We saw results with the pinky almost immediately, and it was actually kind of mind-blowing. Something was happening! Even though you realize what is expected or desired to happen, it was still pretty shocking. The team adjusted the sensor for the ring finger, and after a few minutes had that finger working, too.

“When I made a fist and it actually worked, we all cheered,” he said. “It was so cool!”

Larson was joined on the project by Dressler, a Computer Science major; Jack Neis, also a Computer Science major; and Electrical Engineering majors Daryl Johnson and Jasmyn Loven, with Loven also, like Larson, minoring in Biomedical Engineering.

And besides her skills with power systems, circuitry and 3D printing, Loven had another talent that proved vital: “I can sew,” she said with a laugh.

That proved handy, she said, “because the sleeve we got turned out to be a little too small. So the night before our final presentation, I had to sew in some extra fabric to make it more comfortable.”

Actually, added Dressler, “there was no shortage of challenges that we faced that night before. For example, one of the strings connecting to the fingers snapped, so we had to replace that.”

A multidisciplinary approach

Solving such problems on the fly is part of the point of capstone projects, said UND Associate Professor Kouhyar Tavakolian, the team’s advisor and the director of UND’s Biomedical Engineering program.

“And so is taking part in multidisciplinary projects such as this one,” he said. “For

example, Biomedical Engineering by nature is not an independent discipline. The problems that it tackles do not have just one side to them; they call for people from different areas of engineering, applying all of their skills to solve those problems.”

Larson and her fellow students showed just how much good can result when different disciplines successfully work together, Tavakolian said.

“Plus, this was an idea that they initiated themselves, and then they saw it all the way through to great success. I’m very proud of them.”

Larson – who knows the man for whom the prosthetic was designed – came up with the proposal and first recruited Loven. Johnson, Dressler and Neis followed, as the team’s need for skillsets from multiple disciplines became clear.

A key step was manufacturing the actual prosthetic – the partial hand. The team did this with a 3D printer at UND, using an open-source model of a full hand that the team edited for their own use.

“That took many hours, just to figure out the printer settings and make sure everything ran smoothly,” Loven said.

Testing the sensors – which the team did on each others’ forearms – was another challenge, “especially because the tendons for the ring finger and the pinky finger do a lot of cross-talk,” Larson said.

Even for people with intact hands, the cross-talk makes it hard to move one finger without at least twitching the other. “But we had to be able to distinguish between the signals enough to operate the device,” Larson said.

That’s when she and Loven brought their human-anatomy training – part of UND’s Biomedical Engineering program – to bear, by seeking out the surface manifestations of the complicated layers of muscles in the forearm.



From left to right: Sam Dressler, Jasmyrn Loven, Daryl Johnson (attending remotely, on screen), Megan Larson and Jack Neis.

From the president: ‘Well done’

The end result – a fully-functional partial prosthetic hand, one whose fingers respond to the natural muscle movements of the user – won the praise of UND President Andy Armacost himself. “Congrats, Megan, to you and your team!” the president posted, after Larson had published news and photos of the project on LinkedIn.

“People have been talking about your project on campus for the last couple of weeks! Well done,” Armacost continued.

As for the team members, they’re still savoring the project’s most thrilling moments, such as watching the subject put on the sleeve, strap on the prosthetic – and move his new hand’s ring and pinky fingers for the first time.

“If I had the chance to go back in time and tell my high-school self what I would be doing now, I would honestly be amazed,” Neis said. “It has been an incredible experience.”

Dressler agreed. “I get this wide-eyed reaction from my friends who are in non-STEM fields,” he said. “They look at this and say, ‘Wow, that is so cool!’ It’s really exciting, and I’m so happy I was able to be a part of it.”

The prosthetic itself is a prototype, which means it’s not really meant for full-time, day-to-day use, the subject said. But give it a few improvements such as a custom fit, durable materials, a natural look and an app for battery status and other indicators, “then my only question would be, ‘Where can I buy one?’”

All in all, “great job by this team, and it was so much fun working with them,” he said. “Thank you!”

Written by Tom Dennis

THE BIG IDEA CHALLENGE



The Big Idea Challenge is a student competition to generate novel ideas and innovative ways of solving important problems. The challenge is hosted by the College of Engineering & Mines, but is open to all UND students. Students may work in teams and are strongly encouraged to collaborate across multiple disciplines.

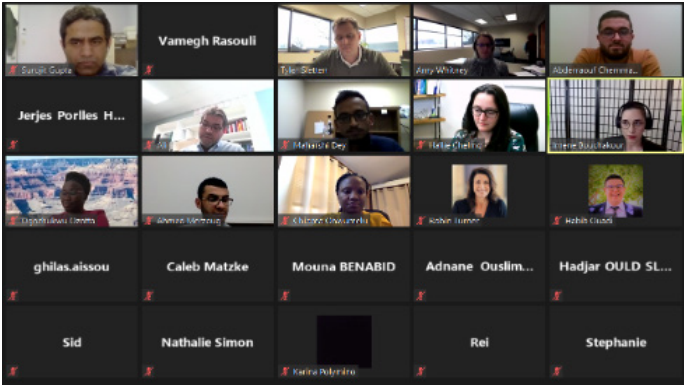
The Big Idea Challenge is sponsored by the College of Engineering & Mines, the Jodsaas Center for Engineering Leadership and Entrepreneurship, and the Edson and Margaret Larson Foundation.

Smart Laboratories for Remote Engineer Training

The Spring 2021 Big Idea Challenge featured three student teams. This timely topic is relevant due to COVID-19, with many lab-based activities occurring online. The winning team by both the judges’ panel and the audience was “Education Sight,” an idea to develop a crowdsourced server for VR/AR lab experiences that colleges and students could access to enhance laboratory teaching and learning experiences. The student team members of Education Sight are Habib Ouadi, Abderraouf Chemmakh, and Ahmed Merzoug.

The 4th Industry Revolution

The May 2021 BIG Idea Challenge focused on “Industry 4.0”, a term used to describe the ongoing automation of traditional manufacturing and industrial practices using modern smart technology. Edson & Margaret Larson Foundation trustees Doug Christensen, Julie Barner, and Andrew Kjos joined the audience to watch the final Zoom presentations. The winning presentation was by Team ProVision, lead by graduate students Ghilas Aissou and Hadjar Ould Slimane. Both graduate students are graduate teaching assistants in the School of Electrical Engineering and Computer Science.



BEST OF THE BEST, AGAIN

For the second time in a row, UND engineering and geology students place first in U.S. Department of Energy geothermal competition

A proposal by UND engineering students to use abandoned oil and gas wells to heat homes won first place in the U.S. Department of Energy’s Spring 2021 Geothermal Collegiate Competition.

UND geology and geological engineering students, working with students at Reykjavik University in Iceland, researched the use of existing gas wells to generate geothermal energy for heat, food and jobs in Mandaree, N.D.

The team is led by Will Gosnold, Chester Fritz Distinguished Professor of Geology and Geological Engineering. This is the latest geology and geological engineering team led by him to place highly in national competitions.

The “Thermal Vision” team from UND took first place in the U.S. Department of Energy’s Fall 2020 Geothermal Design Challenge with their high-quality graphic that illustrated the benefits of geothermal energy production.

The “PIG in a pipeline” crew became semifinalists in the Geothermal Manufacturing Prize, a contest administered by the Department of Energy’s National Renewable Energy Laboratory. The team won more than \$30,000.

“Working with these students in four national competitions during the past two years has been the most rewarding experience in my 44-year career as a university professor,” Gosnold said.

“Each team was multidisciplinary and diverse in many ways and that made a rich stew for ideas and approaches to the challenges in the competitions. The way it all works was elegantly stated by Isaac Asimov in a 1959 essay on how people get new ideas.”

About the geothermal project

As oil and gas wells reach the end of their useful life, they could be repurposed to harvest geothermal heat from the Earth to heat homes and create opportunities for economic development, the students said in their video proposal, adding that Mandaree is a prime location to test the idea.

Located in the Mandan, Hidatsa, and Arikara Nation, Mandaree is in the heart of the Williston Basin and Bakken Formation, the source of much of the nation’s oil.

The proposed project would draw hot water from aquifers deep below the surface to provide heat. The water would later be re-injected into the aquifer to prevent reservoir depletion. Temperatures in the aquifer below Mandaree exceed 70 degrees Celsius (158 degrees Fahrenheit), and are ideal for geothermal heating, the students said.

The warm water could also heat a greenhouse in Mandaree that could provide fruit and vegetables, the students said.

“According to studies done by our team, hundreds of geothermal district heating systems operate around the world,” said Moones Alamooti, UND doctoral student of geophysics. “There are only 21 in the United States. Mandaree has the potential to lead North Dakota into a geothermal energy future.”

About the competition

The U.S. Department of Energy Geothermal Collegiate Competition engages college and university teams to design direct-use concepts leveraging geothermal energy to heat and cool buildings, campuses, districts, or entire communities. Students gain real-world renewable energy industry experience conceiving a use case, performing a resource assessment and usage evaluation, and planning alongside community stakeholders.

Geothermal Team members

Members of the geothermal team are Nicholas Fry, Reykjavik University, master’s in sustainable energy sciences; Moones Alamooti, doctoral student in geophysics; Ogonna Obinwa, master’s student in petroleum engineering; Chioma Onwumelu, doctoral student in geology; Shane Namie, doctoral student in geological engineering; Jerjes Porlles, doctoral student in petroleum engineering; Jessica Eagle-Bluestone, master’s student in petroleum engineering; Nnaemeka Ngobidi, doctoral student in geology; and Matthew Villante and Nicholas Fry, both master’s students in sustainable energy from Reykjavik University in Iceland.

Written by Jan Orvik



Bernard Berntson wearing his Sigma Tau hat alongside his grandson holding Bernard's slide rule from 1961.



Patrick "Pat" Maddock holding his brother's Sigma Tau hat.

A BRIEF HISTORY OF SIGMA TAU'S ICONIC HEADWEAR

An odd-looking piece of historic headwear makes a trip back home to campus

In the spring of 2020, UND alum Patrick "Pat" Maddock (B.S. Law, '64) visited campus carrying what appeared to be a pyramid structure. Pat found the object among his brother's (John Maddock, B.S. Civil Engineering, '59) belongings. Later in the year, a similar object appeared once again. This time, it was through an email to Dean Tande from alum Bernard Berntson (B.S. Mechanical Engineering, '61).

While at first glance, these objects may look like small sculptures, they're actually hats, complete with holes at the bottom to fit an adult's head.

Where did these hats come from - and more importantly - what was their significance to engineering at UND?

The story starts in 1904 with the founding of an honorary fraternity named Sigma Tau. While the fraternity was first based in the University of Nebraska, on April 8, 1922, the Pi Chapter of Sigma Tau was chartered at the University of North Dakota. During the fraternity's existence, many successful engineering students appeared on its membership list, many of who eventually led highly successful careers after graduation.

But how did these hats come into play? During initiation, of course!

At one point on UND's campus, it was a familiar sight to see Sigma Tau initiates walking around campus wearing these homemade, pyramid-shaped, cardboard hats. Initiates cleaning their self-made Sigma Tau headpieces with toothbrushes would attract interested onlookers.

However, these initiates would be carrying an equally unexpected item: a piece of railroad rail.

The objective of creating the Sigma Tau headpiece was to construct it so that the hat could support the heavy piece of rail on top of it. After a successful round of testing, the students would collect signatures from faculty who approved of the construction.

Eventually, the Sigma Tau fraternity was superseded by Tau Beta Pi's honor society. Tau Beta Pi is the oldest engineering honor society and the second oldest collegiate honor society in the United States. It honors engineering students in American universities who have shown a history of academic achievement and a commitment to personal and professional integrity.

A CAREER MOVE

UND's Frank Xiao earns prestigious \$500,000 NSF award for quest to mitigate effects of harmful manmade chemicals

One of UND's most celebrated young researchers just received another honor.

Frank Xiao, assistant professor of civil engineering, received a CAREER award/grant from the National Science Foundation for his anti-pollution work. Xiao studies the use of heat to treat PFAS-contaminated soils, PFAS being an acronym for a group of widely used yet potentially harmful manmade chemicals.

NSF CAREER awards are the Foundation's most prestigious grants that support early-career, not-yet-tenured faculty whose current research and educational endeavors point to future leadership in their respective fields.

Xiao is only the College of Engineering & Mines' second faculty member in more than two decades to have earned an NSF CAREER award. He is among only 15 UND faculty members to have earned the award in the history of the University.

Moreover, Xiao's NSF CAREER grant is his second early-career award from a federal agency, a feat only few academics in the United States have ever accomplished. His first Early-Career grant came from the Environmental Protection Agency.

As part of the award, the NSF has committed \$500,000 to Xiao's PFAS research at UND, which he will carry out over the next five years and employ more than a dozen of students in doing so.

The NSF award will allow Xiao to take on a new direction in his years-long research of PFAS, or per- and polyfluoroalkyl substances.

"I have been studying these chemicals since my Ph.D. actually, since 2010," said Xiao. "I've worked on different aspects such as environmental transport and water treatment, but not on the soil remediation aspect."

A family of nearly 3,000 synthetic chemicals, PFAS have been manufactured in the U.S. since the 1940s. The chemicals once were found in a slate of commercial and consumer products, from nonstick cookware to fast-food wraps to water-resistant clothing. While discontinued in the United States, PFAS are still used in the manufacturing processes of other countries. As a result, products containing PFAS are frequently imported into the U.S.

PFAS accumulate in soil and water as well as the human body. A report by the Centers for Disease Control found that 97 percent

of Americans have PFAS chemicals in their blood. Studies show that PFAS can result in increased cholesterol levels, increased risk of kidney or testicular cancer as well as a higher risk of pre-eclampsia in pregnant women, among other harmful health effects. They are called "forever chemicals" because their chemistry prevents them from breaking down in the natural environment.

"It's very, very alarming," Xiao said, adding that there are more than 400 suspected or confirmed PFAS contamination sites in the country.

Thermal soil treatment

Although PFAS have existed for decades, there aren't any viable methods to remedy their presence in nature. Current abatement approaches are costly and not sustainable outside of a research lab, Xiao said. He wants to change that by researching the susceptibility of PFAS substances to thermal degradation in soils.

Because they are used in products that can withstand relatively high temperatures (such as cookware and firefighting foams), PFAS are commonly perceived to be resistant to fire. But this is a misconception, Xiao said.

Some PFAS chemicals degrade at temperatures as low as 150 °C, while others break down at 450 °C, Xiao found.

"Knowing that, I am thinking, 'Since PFAS can be degraded at low to moderate temperatures, then what happens to them in the natural environment when there's a wildfire, for example?'" Xiao said.

Xiao will seek this answer. His research is two-pronged: how PFAS behave during thermal treatment (e.g., cooking, baking, wildfires) and, subsequently, what remediation practices could be created and effectively applied outside a lab, in the real world.

During the five-year research project, Xiao will employ both undergraduate as well as graduate students, a commitment in line with UND's continued focus to provide experiential and hands-on learning opportunities.

"I enjoying working with students," Xiao said. "Research is also a good benefit for undergraduate students. Even if they don't pursue master's degrees, the experience is still relevant for their professional careers, and it's something they can showcase on their resumes."

Written by Dima Williams



DETECT AND DISINFECT

A pioneering patented technology will detect, disinfect and document contaminants, including human respiratory droplets.

This revolutionary tech is patented technology developed by the US Army with the USDA, modified and enhanced by SafetySpect for commercial applications, researched and scientifically tested by UND and being developed to be FDA compliant.

This new sanitation process, conducted by a CSI-D tool, provides piece of mind that the highest hygiene and sanitation standards are met for corporations, governmental and state organizations.

Supported by a \$1.5 million grant from the North Dakota Department of Agriculture, SafetySpect Inc. - a California-based company - has brought its virus-fighting solution to multiple UND labs for experimentation.

In the lab at the College of Engineering & Mines run by Kouhyar Tavakolian, associate professor, director of the biomedical engineering program and principal investigator on the SafetySpect project, researchers will shine the SafetySpect device on a number of surfaces. Among the surfaces will be samples of the plastics, metals, digital screens and upholstery typically found in airplane cockpits.



LEARN MORE

Scan with your phone's camera app to read more about this project.



Andrew Dockter, a Chemical Engineering student at the UND College of Engineering & Mines, is one of many students who will benefit from Lynne's thoughtful and generous donation.



HONORING THE LIFE OF W. ALLAN HOPKINS

Lynne's donation will aid students researching in the Institute of Energy Studies lab named after her brother-in-law

Chemical Engineering senior Andrew Dockter, hometown Washburn, ND, is pictured with the OHAUS Scout SKX Portable Balance. The portable balance has two major functions: weighing and density determination. Andrew uses this as part of the IES research he does with the battery team to develop high capacity and longer-lasting lithium-ion batteries — research that is done in the Al and Claire Hopkins Lab located in the Collaborative Energy Complex.

The purchase of this high precision scale was made possible through the generosity of Lynne Ebner in memoriam to honor her brother-in-law Al Hopkins. Thank you, Lynne!

Al Hopkins earned his Bachelors of Science in Civil Engineering from the UND College of Engineering & Mines in 1962. After graduating from UND, he held multiple positions at Stelco, Inc. and eventually became the company's Senior Vice President. He later became the President & CEO of Algoma Steel Inc., and finally the President and CEO of Atlas Steel Inc. In 2019, Al was inducted into the UND College of Engineering & Mines Alumni Academy.

GIVE A GIFT THAT KEEPS ON GIVING

Are you considering lending your support to CEM like Lynne Ebner, or perhaps in your own unique way? There are numerous ongoing opportunities to lend financial support to the College. We will work with you to ensure the stewardship of your gifts of time, talent, or treasures.

Scholarships create opportunities for talented students to earn a degree, regardless of their ability to pay. **Endowments** provide the foundation for continued innovation, strengthening the educational experience over the long term. Support for **faculty chairs and professorships** enables us to attract and retain top scholars who

bring distinction to the College. **Unrestricted gifts** to support the College's immediate needs provide resources to academic programs, faculty support, scholarships, facilities, technology, and laboratory equipment. Meanwhile, **legacy gifts** to the College live on at UND forever.

For more information about giving opportunities, contact Robin Turner at robin@UNDfoundation.org or give a call at 701.777.1428.



2020 North Dakota AGC Scholarship Award Recipients along with AGC of North Dakota leaders and CEM representatives



2021 AGC Scholarship Award Recipients along with Sally Miskavige (President, AGC of ND & VP, Opp Construction)



2020 Freeman Award Recipients along with Brendan Kennelly (Senior Manager of Power Delivery, Minnkota Power)

NORTH DAKOTA AGC SCHOLARSHIP AWARDS

Thank you to the Associated General Contractors of North Dakota for awarding students scholarships to support their education! Representing the North Dakota AGC, Sally (Opp) Miskavige, Dan Swingen, Russ Hanson and Paul Dietrich visited campus during fall 2020 to hand-deliver scholarships to three CEM students. During their visit, the students were given the opportunity to connect with the representatives and share their aspirations and goals.

The AGC team returned this fall to make an unprecedented presentation to four women in the Civil Engineering department. "The candidates were so strong and the essays they submitted moved us to add a special fourth honorary award this year," said Russ Hansen, AGC Executive Vice President.

The strong relationship between the North Dakota AGC and the College of Engineering and Mines goes back for over half of a century. In fact, the John Jardine Scholarship, one of three scholarships funded by the ND AGC, is now going on 56 years strong.

The 2020 and 2021 North Dakota AGC scholarship recipients are very grateful for this great opportunity and look forward to building their future careers in Civil Engineering.

2020 SCHOLARSHIP RECIPIENTS

Reed Turner | Walt Swingen Scholarship
Brian Aafedt | John Jardine Scholarship
Samuel Larson | Don Lindberg Scholarship

2021 SCHOLARSHIP RECIPIENTS

Savana Schauer | Walt Swingen Scholarship
Brianna Metzger | John Jardine Scholarship
Betsy Seaver | Don Lindberg Scholarship
Nicole Dolejs | Honorary Scholarship

ANNUAL FREEMAN COMPETITION

A year of COVID challenges didn't stop the University of North Dakota's engineering students from using teamwork and innovation to enhance lives, and they were recognized for their perseverance at the 2021 Andrew Freeman Design Innovation Competition awards ceremony.

Several undergraduate teams presented their senior design projects to industry leaders – including representatives from Minnkota, which has sponsored the Freeman Competition for more than 20 years. The winning project was a safety app developed by two engineering students for the Grand Forks County Emergency Management Department.

Engkvist and his teammate, Sean Larsen, received a \$2,000 award for their work, supported by an endowment established in 1996 to honor Andrew "Andy" Freeman, a UND engineering alumnus and former 42-year Minnkota general manager.

The second-place team recognized in the competition developed a process to produce a bio-based substance that can be used in flexible polyether for adhesives and foams. Third place was awarded to a project that revamped an assembly station at the Grand Forks-based manufacturing company Retrax to increase efficiency, savings and safety. The teams received \$1,000 and \$500 awards, respectively.

First Place: Grand Forks County Safety App \$2,000.00 Team Award

Team Members: Gannon Engkvist, Sean Larsen

Second Place: A Novel Process for the Production of Bio-based Polyethers from Corn Stover Derived 1, 4Pentanediol \$1,000.00 Team Award

Team Members: Akash Gogate, Maddisyn Kemmer, Emily Myskewitz, Levi Stegner

Third Place: UND Retrax Sr. Design \$500.00 Team Award

Team Members: Pablo Guerrero, Jaxon Kriewald, John Munro, Kevin Simon, Lucas Strozinsky



ACHIEVEMENTS & AWARDS



UND Founder's Day Award Recipients

Founders Day is the annual celebration of our history as an institution and a time to honor members of our campus community. Retirees with 15 years or more of service, employees with 25 years of service, outstanding faculty, departments, advisors, and researchers are traditionally honored at an event on the last Thursday in February — commemorating the founding of the University in 1883. The following are recipients from the College of Engineering & Mines:

Gautham Krishnamoorthy

UND Foundation/McDermott Faculty Award for Excellence in Research & Creative Activity

Frank Bowman

UND Foundation Award for Excellence in Teaching, Research or Creativity, and Service

UND Award for Excellence in Online Course Development and Innovative Teaching Strategies

Stacy Bjorgaard

UND Award for Excellence in Online Course Development and Innovative Teaching Strategies

Retiring CEM Faculty & Staff

Lowell Stanlake

Assistant Professor, Mechanical Engineering
With UND since 1976

Kristie Wolff

Undergraduate Programs Coordinator
With UND since 2011

Promotion to professor

Howe Lim

Associate Professor & Graduate Program Director
Department of Civil Engineering

Promotion to Associate Professor with Tenure

Taufique Mahmood

Assistant Professor
Geology & Geological Engineering

Minou Rabiei

Assistant Professor
Petroleum Engineering

Frank Xiao

Assistant Professor
Civil Engineering

UND Team designs pipeline-scrubbing 'PIG,' wins geothermal manufacturing prize

Before winning first place in the Geothermal Design Challenge, the UND team won the U.S. Department of Energy's Geothermal Manufacturing Prize. The team designed a "Pipeline Interventions Gadget" (PIG) to remove the scale deposits. The PIG would be able to operate at high temperatures, and would basically "scrub" pipelines under pressure while solving problems with previous technology, such as breakage, difficulty tracking, and other issues. It would help reduce pipeline costs and improve efficiency.

Three Minute Thesis (3MT) Annual Competition

The UND Three Minute Thesis (3MT) celebrates research being done by students at the University of North Dakota. The competition culminates students' academic, presentation and research communication skills, as each must effectively explain their research in three minutes with only one PowerPoint slide. Nearly half of all this year's participants represented CEM, with two of those students taking first and second place in the competition.

Nidhal Badrouchi

First Place

Pavan Challa

Second Place

Competitors

Miranda Shanks - Finalist
Niroop Sugunaraj - Finalist

Outstanding Faculty & Staff Awards

The annual Faculty & Staff Awards, presented by the Dean of the College of Engineering in Mines, give recognition to faculty and staff members that have gone above and beyond within the past year.

Jeremiah Neubert

Professor
Mechanical Engineering

Frank Xiao

Associate Professor
Civil Engineering

Darin Buri

Facility & Library Manager

Kathie Johnke

Administrative Support Specialist

NSF Early CAREER Award

Frank Xiao

Frank Xiao, Assistant Professor of Civil Engineering, has been awarded the Early Career Award by the National Science Foundation (NSF). In 2019, Frank was awarded a separate Early Career Award on behalf of the U.S. Environmental Protection Agency. Between these two prestigious awards, Frank received an Excellence in Review Award from ACS Journal Environmental Science & Technology Letters, published in American Chemical Society Journal, and has had his articles recognized as "Highly Cited Papers" by Web of Science.

Read more on page 33.

UND team wins U.S. Department of Energy design competition

Three grad students in geophysics and petroleum engineering teamed up to enter the DoE's Fall 2020 Geothermal Design Challenge, and won. During the competition, students from across the United States designed powerful, high-quality infographics to illustrate aspects of geothermal energy production, backed by robust technical data and accompanied by communications and outreach strategies to maximize impact.

Read more on page 31.

UND Student Organization Leadership Awards

Engineers Without Borders

Engineers Without Borders, a student organization focused on assisting developing communities worldwide in order to improve their quality of life, won the Student Organization Of The Year Award at the 2021 Leadership Awards Ceremony on April 16, 2021. The student organization advisor, Dr. Howe Lim, also won the Outstanding Advisor Award. The president of the organization, Jonathan Wirkkala, won the Lillian Elsinga Outstanding Student Leader Award.

Read more about their project on page 25.

Petroleum Engineering Team wins 2nd place at International Switch Energy Case Competition

The UND Petroleum Engineering team has won the second place (out of 250 teams) for the International Switch Energy Case Competition. The team won \$2,500 in prize money for their placement in the competition. This year, the competition received over 900 university students from 37 countries and six continents formed approximately 250 teams. The final presentations between the top 7 teams were held on Saturday, November 14.

UND Nabs \$5M Contract to Develop Augmented Reality Tech for U.S. Army

UND and its research partners have been awarded a \$5 million contract from the U.S. Department of Defense to develop augmented reality technology for U.S. Army vehicles.

Read more on page 28.



Dr. Daba Gedafa Elevated to ASCE Fellow

Daba Shabara Gedafa, Ph.D., P.E., ENV SP, F.ASCE, Associate Professor and Civil Engineering department chair at the University of North Dakota, has been named a fellow by the ASCE Board of Direction. Gedafa's service goals are to help the department, college, university, profession, and community move forward. He has served on 10 university committees, including senate executive committee, five college-wide committees, and all department-level committees. He has advised four student organizations and been selected as UND's Outstanding Advisor.

Excellence in Dissertation Writing Award

Shaojie Zhang

Shaojie Zhang has been selected as by UND Graduate School of Graduate Studies as the recipient of the 2021 Excellence in Dissertation Writing Award for his dissertation titled, "Enhanced Hydrocarbon Recovery in Tight and Shale Reservoirs Using Surfactants and Supercritical CO₂". This award is given to a student who produced an exceptional dissertation of outstanding quality. "It is clear from the nomination packet that you were a very motivated student who produced high quality papers and presentations while in the program. Publication of two of your dissertation chapters is a great achievement and shows the quality of your work," writes Chris Nelson, Associate Dean, School of Graduate Studies.

CEM Team Wins First Place at the U.S. DOE Geothermal Collegiate Competition

A proposal by UND engineering students to use abandoned oil and gas wells to heat homes won first place in the U.S. Department of Energy's Spring 2021 Geothermal Collegiate Competition.

Read more on page 31.

CEM Top National Rankings

#1 Best Electrical Engineering Degree Program

OnlineU.com, Intelligent.com

#3 Best Online Engineering Bachelors Program

Guide to Online Schools

#5 Best Online University in the Nation

EDsmart.com

#5 Best Civil Engineering Masters Program

Intelligent.com

#7 Best Online Electrical Engineering Bachelors

Bachelorsdegreecenter.org

Top 20 Best Colleges in the Nation

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UNDalumni.org/guide-to-giving | 701.777.2611
1.800.543.8764 | giftplanning@UNDfoundation.org

**A MESSAGE TO OUR
ALUMNI & FRIENDS**

“Far and away, the best prize in life offers is the chance to work hard at work worth doing.” On September 7, 1903, that was the assertion made by Theodore Roosevelt. This past year, as we continued to readjust our personal and work lives, we’ve had moments to focus on the concept of “work worth doing.”

What makes what we do worthwhile? To answer this, we look to our incredibly motivated students and alumni. We work hard to provide our students with the best education we can offer. Each graduation ceremony, we watch the next generation

of doers launch into their professional lives with the knowledge and skills they earn at UND. As we celebrate each of their post-education successes, they turn around to celebrate their alma mater: a never-ending cycle of care, pride and hard — yet meaningful — work.

From the hearts of students, faculty and staff here at the UND College of Engineering & Mines, we sincerely thank all alumni and friends who have made gifts and commitments to support students, faculty and programs throughout the pandemic. You make our hard work worth doing.



Deb Austreng
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CEM Annual Excellence Fund

The Annual Excellence Fund makes a tremendous difference in everything we do for our students. Our students’ experience is dependent upon your generosity and support of our students, faculty and programming.

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EVERY YEAR

Make your sustained impact on the college by giving annually!

MAKES A DIFFERENCE

Every student is impacted by your support! When we seek help from our alumni and friends, the lives of our students are forever changed.

**You can make a gift at
UNDalumni.org/CEM**

It’s been an exciting and event-filled fall on campus this year with the return of students, faculty and visitors. If you’re interested in exploring the CEM building, meeting with administration, faculty or students, contact either Deb or Robin to schedule a time that works best for you. In the meantime, enjoy this recap of some of the excitement that occurred this past year.

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Find your own work worth doing at
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Want to know more about these and other stories? Visit our blog at blogs.UND.edu/cem. Follow us on social media to stay tuned to all College of Engineering & Mines' news, updates, and stories!

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