NORTH DAKOTA STATE UNIVERSITY

FOUNDATION

MAGAZINE | VOLUME 3 | ISSUE 1 | FALL 2023

ENGINEERING THE FUTURE

GIVING DAY NDSU

#GIVE TO

SUPPORT STEM STUDENTS
FOSTER BISON PRIDE
INSPIRE THE FUTURE

MAKE YOUR GIFT ON NDSU GIVING DAY!
Nov. 28, 2023

Since **Brenna Solheid '25** was a young girl, one family member was insistent: "You're going to be a woman in STEM!" Today, Brenna is a junior at NDSU majoring in mechanical engineering and minoring in Spanish with an internship at John Deere under her belt.

"I just really loved math and science," Brenna said. "Engineering takes the science and math that I like, plus problem-solving, and applies it to helping people. It's the perfect mix."

As a scholarship recipient, Brenna can invest more time in her studies and campus activities, from Bison Ambassadors, where she represents the University as a student leader and engages with alumni and friends, to the Society of Women Engineers, where she gets to teach and inspire kids interested in STEM.

Seeing NDSU alumni support the University increases her Bison pride.

"It's so beneficial; every student appreciates it. Just to see that people want to give back so much, it helps students realize how much NDSU cares."

On **Tuesday, Nov. 28, 2023**, join a community of NDSU alumni and supporters in celebrating NDSU Giving Day. During this one-day, online fundraising event, you can give to the areas of campus you are most passionate about to support the future of NDSU and enhance the student experience.

Check out matches and challenges to make your gift go farther — and make your gift on NDSU Giving Day at **NDSUGivingDay.com**!

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FOUNDATION MAGAZINE

VOLUME 3 | ISSUE 1 | FALL 2023

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Since its founding in 1890, NDSU has traced its impact to one of its inaugural programs: mechanic arts. Today, we know mechanic arts as engineering. In those early years, our region was experiencing rapid growth and expansion, and NDSU rose to meet this need.

Edward S. Keene became NDSU's first professor of engineering in 1892. Fueled by a shared vision for hands-on education and practical experiences that really mattered, Edward focused on teaching fundamental skills and problem-solving to his students. These students applied this knowledge to growing the state's economy, communities, and citizenry. Edward eventually became the dean of engineering and even served as acting president of the University from February to September 1921 before resigning in 1926.

After World Wars I and II, interest in engineering exploded, creating the need to expand education and lab spaces for student learning. Much of today's engineering complex was constructed in the 1960s at NDSU.

More than 22,000 individuals have received engineering degrees from NDSU, representing 20% of our total alumni population. Our alumni have left — and continue to leave — a lasting impact everywhere. With the rise of agriculture and energy as dominant industries in North Dakota, Bison engineers have led the way.

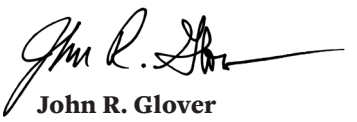
Today, NDSU stands as a beacon of engineering excellence, building upon its proud past while looking to the future. Inside this issue, you will learn more about the impact of our faculty, staff, students, alumni, and industry partners. Practical, brilliant engineers are needed more than

ever to make positive, life-changing impacts on our society.

Thanks to the 68th North Dakota Legislative Assembly, NDSU is now developing plans for a new Center for Engineering and Computational Sciences, with a price tag of $84 million. The Center will be in the heart of the engineering complex.

This public-private partnership will revolutionize the student and research experience at NDSU, bringing together the next generation of graduates and leaders to guide us through the 21st century. Private gift support of $25 million to $30 million will be needed to make this dream a reality. The NDSU Foundation's team is partnering with the College of Engineering to build awareness, engagement, and support for the project. NDSU intends to begin construction in the summer of 2025.

We hope you will enjoy learning more about Bison engineering, and please contact us if you'd like to learn more about how you can be involved.



John R. Glover
President/CEO
NDSU Foundation

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Mission: Preparing innovative problem-solvers and creating new knowledge to improve lives in North Dakota and beyond.

NDSU

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Grants, awards, and philanthropic support designated for research.

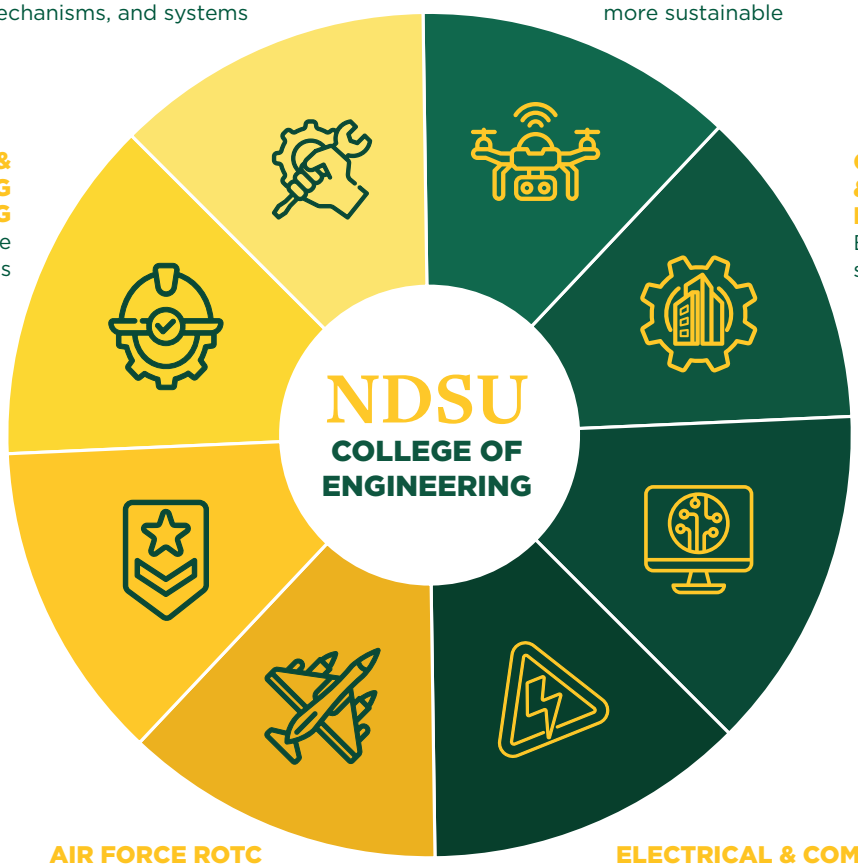
MORE THAN **$10.5** MILLION

Data from NDSU's Office of Research and Creative Activity for fiscal year July 1, 2022, to June 30, 2023.

PHILANTHROPIC SUPPORT
Gifts for scholarships, faculty, facilities, and programs.

MORE THAN **$32** MILLION

Data from the NDSU Foundation's In Our Hands *campaign (Jan. 1, 2016, to Dec. 31, 2021) to June 30, 2023.*



MECHANICAL ENGINEERING
Designing machinery, mechanisms, and systems

AGRICULTURAL & BIOSYSTEMS ENGINEERING
Making farming safer and more sustainable

INDUSTRIAL & MANUFACTURING ENGINEERING
Implementing effective production processes

CIVIL, CONSTRUCTION & ENVIRONMENTAL ENGINEERING
Building solutions for societal infrastructure

ARMY ROTC
Developing leaders of character for the U.S. Army

COMPUTER SCIENCE
Driving innovation through computer programming and theory

AIR FORCE ROTC
Developing leaders of character for the Air Force and Space Force

ELECTRICAL & COMPUTER ENGINEERING
Developing electrical and computer equipment and systems

NDSU COMPUTER SCIENCE LEVELS UP

Building new worlds in video games, predicting environmental disasters, and preventing cyberattacks — 50 years after its inception, NDSU's computer science program is more innovative and in demand than ever.

<story> by Emily Erickson '15 | Photo by Ann Arbor Miller

On a Saturday afternoon in the Quentin Burdick Building, NDSU students populate computer labs, focused on their glowing computer screens. It is quiet aside from typing, clicking, and the occasional whisper.

To a passerby, this is nothing more than a group of productive students. To the focused coders in question, this is a high-intensity annual tournament — the Byte-le Royale — and the rest of the day will be filled with stress, strategy, and fun.

One of the competitors is NDSU student Grace De Genaro '25. Originally from Lakeville, Minnesota, Grace is a junior in the computer science program and a member of the Association for Computing Machinery (ACM).

In the Byte-le Royale, Grace and her teammates have been tasked with writing artificial intelligence using Python API (a high-level programming language) to program a bot to "play" the video game designed by ACM developers — in under 12 hours. There are action options, opportunities for points, and things that can go wrong. After a day of coding, algorithms, and good old-fashioned trial and error, a cash prize is awarded to the highest scoring team.

Activities like the Byte-le Royale provide students like Grace opportunities to get their proverbial hands dirty and see tangible results from what they learn in their computer science classes. Hands-on educational experiences are essential for today's computer science students — some of the most relevant issues of the day may not have made it to textbooks yet. They also sharpen foundational skills for an education and career in computer science.

"I've learned to work under pressure," Grace said. "Working fast and efficiently is important, but you also can't let setbacks in your code affect you too much. Just take it in stride and learn from your mistakes. Everyone encounters bugs."

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For Grace, going into computer science at NDSU meant having the freedom to integrate her skills and passions and align them with her personal values.

"I'm a very creative person. I wanted a career where I could expand on that creativity," Grace said. "I would really like to do something working with environmental preservation. Technology unfortunately has a very big impact on the environment; everything consumes

energy. I would like to give back everything I might be taking away."

To reach her goals, Grace hopes to find a career in data science or data analytics, fields that combine math and statistics, specialized programming, advanced analytics, AI, and machine learning with specific subject matter expertise to uncover actionable insights hidden in an organization's data, as defined by IBM.

Data scientists can apply environmental monitoring, predictive modeling, conservation planning, and other methods of using data to address environmental issues. Grace provided an example of tracking air quality and pollution. Someone experienced in gathering data and running simulations could help predict what actions may need to be taken in the future to prevent environmental disasters.

To find someone with a research background in data science, Grace doesn't need to go far — down the hall from her office as the student IT communications specialist in the Quentin Burdick Building, she will find the office of ACM faculty advisor and James A. Meier Junior Professor Anne Denton. Anne's professorship was funded through an endowment established by James A. Meier '59, '71, '07. James' investment has provided research funding for many NDSU faculty members.

In Anne's teaching and research, she prioritizes hands-on learning and what she calls "practical relevance." Most of her courses incorporate an open-ended project — for which students propose the objective and concept — allowing them to apply the skills they learn in the course in a practical context. It also rewards their creativity.

Anne's data science research focuses on agriculture — specifically, remotely sensed data using drones, airplanes, satellites, and sometimes hand-held sensors.

Satellites have been used since the 1970s in agriculture to determine the difference between near-infrared and visible light that tells farmers which parts of the field have good, healthy plant growth and which ones do not. This concept is known as the normalized difference vegetation index (NDVI). The NDVI can help farmers identify areas that may be stressed or experiencing nutrient deficiencies, optimize irrigation and fertilization practices, or monitor growth and development of crops over time to estimate yields.

For the last 50 years, these satellites have captured imagery at 100 feet by 100 feet. With new technological advances, satellites can capture imagery at much smaller fractions — 10 feet by 10 feet, 1 foot by 1 foot, or even smaller than that — meaning scientists and farmers can access additional information. For Anne, that prompts the question: How does that change the objective and implementation of algorithms that can be used?

Anne's research group has developed algorithms for extracting complex properties for every point in an image. In comparable processing time, the algorithms make use of thousands of neighboring points for each image point, where existing approaches rarely use more than eight immediate neighbors.

Anne's research and teaching also address some of the prominent topics of the day: ethics and AI.

"The ethics of artificial intelligence and machine learning has just in recent years seen a massive increase," Anne said. In her class Artificial Intelligence, Ethics, and the Environment, students focus on geospatial AI applications and their ethical implications.

Today's faculty, students, and researchers are actively preparing to address practical and ethical concerns in the computer science field and beyond. For example, Jeremy Straub, an associate professor of computer science at NDSU, looks for solutions to national technical and regulatory challenges and also

<caption>. **GRACE DE GENARO '25** photographed in a Quentin Burdick Building computer lab. </caption>

considers their impacts within North Dakota.

Jeremy is the director of the NDSU Institute for Cyber Security Education and Research and a 2023-2024 senior faculty fellow at the Sheila and Robert Challey Institute for Global Innovation and Growth, an interdisciplinary research institute with the goal of advancing understanding in the areas of innovation, trade, institutions, and human potential to identify policies and solutions for the betterment of society. Founded thanks to philanthropic gifts, the Challey Institute was launched in 2019 and named in honor of Sheila '23 and Bob '67, '09 Challey, who provided the leadership gift to establish the Institute.

One of Jeremy's primary research and teaching focuses is cybersecurity, a subject that would benefit everyone to have some knowledge about.

"We all interact with technology every day," Jeremy said. "We need to know how it works. We need to make sure it's secure." He develops AI techniques in his research with a focus on their application to cybersecurity.

"It turns out that the artificial intelligence that's used to command a robot and the artificial intelligence that you can use to detect or prevent a cyberattack or take a corrective action are very similar," Jeremy said.

His intention is to look at national and international issues and ideas — such as autonomous vehicle licensing and technology regulation — to both solve the larger challenges and to ask what they mean to North Dakota.

Jeremy believes that NDSU has the opportunity to be the lead university in the region in terms of cutting-edge research and education, which is why he has focused his philanthropic giving on the cybersecurity program. Philanthropic support enables research throughout the University — from the James A. Meier professorships to Jeremy's faculty fellowship through the Challey Institute. He sees philanthropic giving as a chance to create an outsized impact and support the next generation of professionals.

"It's about generating people that can solve these cybersecurity challenges of tomorrow," Jeremy said. "There's just so many things that we can do to enrich the environment — not only have good classes, but to also have a really good student experience both for the on-campus and the distance students."

Just as technology transforms, NDSU's computer science department evolves to keep pace with advancements. In the fall of 2019, the department moved from the College of Science and Mathematics to the College of Engineering. New specialized certificates have become available to students as needs have arisen, and in the fall of 2023, NDSU will offer a brand-new major: a Bachelor of Science in cybersecurity.

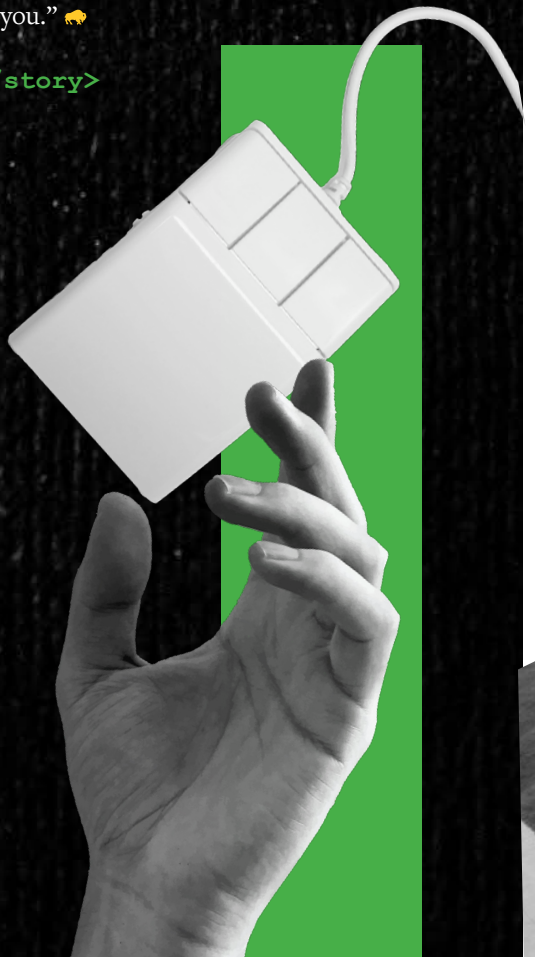
The new degree aligns with NDSU's proposed strategic investment areas, which include cybersecurity, data science, and information technology, along with 14 others. The proposed strategic investments are part of NDSU Transform — an effort initiated in 2022 to "transform the University to meet future workforce and research challenges facing North Dakota and beyond, positioning NDSU for future success."

After NDSU Transform, the creation of the cybersecurity degree, and research in AI, the department's capabilities and priorities may be unrecognizable to NDSU's computer science pioneers in the 1970s.

For example, in 1972, the year before computer science was offered at NDSU and two years before the inception of NDSU's ACM, game developers at Atari released Pong, the legendary table tennis-inspired arcade classic. A half-century in the future, students at the University sit at their personal computers developing bots to play video games in the span of 12 hours.

Between then and now, one thing remains consistent: a spirit of innovation and the excitement of discovery. According to Grace: "[I]f you want to know something, there's probably going to be someone in that room who can teach it to you and would love to teach it to you."

</story>



INNOVATION ACROSS GENERATIONS:

The Doosan Bobcat Story

Doosan Bobcat's $4.5 million investment in STEM scholarships at NDSU is shaping the next generation of industry leaders.

Story by Drew Taylor '15, '25
Photos by Doosan Bobcat

Since its founding in 1947, Bobcat has been driving innovation and advancement in many industries. Its roots in compact machinery stretch back to the late 1950s with the Keller brothers' original concept for a lightweight, belt-driven loader designed to operate in a turkey farmer's barn in Rothsay, Minnesota. After some retooling towards a clutch-based transmission, in 1962 the first compact loader was launched under the Bobcat name in honor of the agile and industrious prairie animal. Forty-five years later, in 2007, Bobcat joined the South Korean Doosan Group. It continues to expand its catalog of compact equipment, attachments, grounds maintenance, and construction-related products and services.

As Doosan Bobcat continues to innovate for the future, it sees immense potential in the bright, young minds of NDSU students. In 2015, the company invested $3 million to fund scholarships for students in STEM-related fields at NDSU. The gift was matched by the North Dakota Higher Education Challenge Grant Fund for an additional $1.5 million, and today the endowment disburses roughly $186,000 annually in scholarships. At the time of its establishment, the commitment was one of the largest gifts received by NDSU from a corporate partner.

"Our company's foundation is built on innovation and the ingenuity of our people, many of whom are NDSU graduates, so supporting the NDSU STEM scholarships is a priority for us," Joel Honeyman '93, '96, vice president of global innovation at Doosan Bobcat, said. "We value our relationship with NDSU and want to provide educational opportunities to teach and inspire students to thrive in an ever-evolving world."

Joel Honeyman sees investing in STEM in North Dakota as a natural part of creating a thriving workforce.

"As a North Dakota-based company with so many employees with strong local roots, we

Doosan Bobcat's North American Headquarters located in West Fargo, North Dakota

value our relationship with NDSU and remain committed to nurturing the state's and region's future innovators, engineers, and technology leaders," he said. "Whether STEM graduates end up working at Bobcat or other organizations in the region, having technology and engineering talent in our communities is a benefit to all of us."

One of those North Dakota communities, Gwinner, holds a special place in Bobcat lore as its first headquarters. It's also the hometown of Drew Asche '21, a third-generation NDSU alumnus and Bobcat engineer.

"My grandpa worked at Bobcat as an engineer. My dad did as well. Now I do, too," Drew said. "From a family standpoint, it's always been an interest to me to work at Bobcat, and it's also been a source of pride that this world-renowned product comes from your little hometown."

Drew, now an engineer in the global hydraulics group at the Doosan Bobcat Acceleration Center in Bismarck, North Dakota, was a recipient of the Doosan Bobcat STEM scholarship. He got his first hands-on chance working at the company during a summer internship, which was quickly followed by a co-op, where he helped design an excavator. A co-op, or cooperative education, provides students with academic credit for structured job experience. Drew's co-op experience paved the way for him to get hired a full semester before he graduated, and he took the opportunity to work part time while he finished his coursework.

Doosan Bobcat's internship programs are as diverse and rigorous as the array of machinery it manufactures. The company actively recruits the next generation of pioneers and trailblazers by offering a range of programs tailored to meet the needs of students at different stages in their education. Doosan Bobcat's co-op program allows college students to dive into real-world projects. Students from a variety of disciplines can additionally work part time during the school year and full time over the summer, gaining invaluable hands-on experience.

Doosan Bobcat also offers the Engineering Prototype Intern Program to freshman or sophomore students who are pursuing technical or engineering degrees. This program allows students to focus on shop work and offers design, test, or electrical-focused projects.

Paighe Wetzstein '23, who graduated this past spring with a bachelor's degree in statistics, also received the Doosan Bobcat scholarship, which motivated her to apply for a co-op position. She began her co-op during her sophomore year and continued all the way until her graduation, all the while attending NDSU full time.

Because she obtained different skills in her co-op and in the classroom at NDSU, Paighe found the experience to be central to her career.

"When I first got this co-op, I thought, 'All of this has nothing to do with what I'm seeking.' But, looking back, my advice would be: get an internship, get a co-op," Paighe said. "It does not matter where it is, because even though this was not what I originally thought I was going to be doing, I love it, and now I have a whole career ahead of me."

Co-ops and internships often lead to full-time employment, as Joel Honeyman notes.

"The co-op program that exists between Bobcat and NDSU allows students to work at Bobcat, putting learning into practice to contribute to real projects. As NDSU graduates are among the best and brightest, we hire many of its students to become part of our team — and I believe our people are some of the most qualified and innovative in the industry."

Paighe's case was a little different from that of most students. During her co-op, she worked as a strategy analyst with a multitude of responsibilities, but unlike most co-ops that simply transition into a full-time position with expanded duties, Doosan Bobcat recognized the importance of her work in setting internal goals on how the company can reduce its impact on the environment. Consequently, the company created a position specifically for her to collaborate with facilities across its footprint to exercise environmental

social governance (ESG). For Paighe, this is a core value of the company.

"In order for us to be successful, we have to keep innovating and coming up with things that are relevant to the community, that will impact our community in a better way," Paighe said.

Joel Johnson '22 is one of those innovators of sustainable and safety-first solutions. He worked at Doosan Bobcat for over a year and a half as a co-op and intern before graduating into a full-time position there.

"Bobcat gave me the opportunity to develop my skills as an engineer while I was in school, and I got paid to do it. Plus, the things that I learned at Bobcat were often complementary to what I was learning at school," he said. "For example, when I was taking computer architecture, I was also looking at some assembly code at Bobcat, so my understanding of the concepts that I was learning in class accelerated."

While this type of synergy is common in co-ops and internships, Joel Johnson notes another interesting synergy in the work he's been doing in the six months since he graduated: developing radar-sensing technology for the Doosan Bobcat lineup.

"We want to add visibility for the operators of our machines. One way to do that is by adding tailgate radars that would be able to sense things that the operator would normally have very limited visual awareness of, which could potentially prevent an accident. But the more visibility we add to the operator, the closer we get to having the ability to create autonomous vehicles. We're adding visibility not only to our operator, but also to the computer inside the machine. We're moving closer to having machine vision where the machine is able to see for itself and make decisions for itself."

In addition to the co-op and internship programs that Joel Johnson, Paighe, and Drew have taken advantage of, Doosan Bobcat offers the unique Student Development Program that specifically targets NDSU engineering students who have previously held a co-op position at Bobcat. This program, which operates part time during the school year, allows students to work on more complex projects compared to the co-op program, providing a deeper understanding of the industry. Co-op students and interns can also participate in the Bobcat Bootcamp, which provides firsthand experience with Bobcat products and a unique perspective that transcends a traditional classroom setting.

These programs, in tandem with the Doosan Bobcat scholarship for NDSU STEM students, are part of a multifaceted effort by Bobcat to build a strong working relationship with NDSU and its students, Joel Honeyman states.

"Like other manufacturers and employers in the state, recruiting, growing, and retaining a quality, skilled workforce is an ongoing challenge. For Bobcat and other regional companies to remain competitive, we need the best and brightest engineers working across our sites."

Private-public partnerships, like those between Doosan Bobcat and NDSU, have a profound impact on students' education and careers. The relationship between Doosan Bobcat and NDSU is a testament to the power of collaboration between industry and the University, shaping the future for both students and businesses, and it all begins with scholarship support.

"I see a scholarship as an investment into someone or something, and with any investment, like in the business world, you really want that investment to grow. You don't want it to depreciate," Drew said. "When I view it as an investment, it makes me want to work harder to show my investors that their money is being put to good use and growing in value."

The Bobcat RogueX, unveiled in March 2023, is a next-generation concept loader that explores the capabilities of electric power, autonomous operation, and dual lift-arm geometry. As a research and development project, it is not commercially available.

Engineering the Future

Kids of all ages are invited to experience what it means to be an engineer at annual outreach opportunities hosted by NDSU's College of Engineering.

Story by Micaela Gerhardt | Photos by Ann Arbor Miller

An engineer is someone who _____.

(A) Builds things,
(B) Thinks of things for stuff to work,
(C) Works with machines, or
(D) Tries something again and again

ALL OF THE ABOVE, according to the third through fifth grade students in the Rockin' Robots class at the NDSU College of Engineering STEM Kids Camp, held annually in the summer.

Emily Balluff '23, a mechanical engineering student who currently leads NDSU's rocket propulsion design team, taught the Rockin' Robots class. On the first day of camp, she asked her students to fill in the blank. Then, she delivered the mic drop.

"An engineer is a problem-solver," Emily said. "You can be an engineer at any point in your life. Kids can be engineers — amazing engineers — because they have very unique ways of solving things. Some people, like me, choose to get a degree in engineering to learn more about it, but really anyone can be an engineer. Engineering isn't a job, it's a way of thinking."

The STEM Kids Camp, hosted by the College of Engineering, is designed to spark kids' interest in science, technology, engineering, and math (STEM) in a fun, hands-on environment. NDSU students, faculty, staff, and local schoolteachers lead classes like Rockin' Robots, STEM in Space, Chemistry Chaos, Crime Scene Science, Creative Computer Coding, City Superheroes, and more, inviting kids in grades K-8 to explore new ideas and gain confidence interacting with STEM subjects.

The College of Engineering also offers a STEM camp targeted toward high school students called Exploring Engineering.

"Every child has that innate sense of wonder about our world and how it works," Angela Gross, outreach coordinator for the College of Engineering, said. "With the help of some expert educators, we were able to expand our offerings this year. Because of that, we saw a marked increase in the cultural and educational diversity of our student population. This is exactly what we want our camp to be — that opportunity for any student to dive in and explore those things they are curious about."

NDSU civil engineering faculty Trung Le and Ying Huang taught the City Superheroes class for students in grades six through eight. Trung is an assistant professor and director of NDSU's Computational Fluids Lab, and Ying is a professor and Welch Faculty Fellow. Both are also parents of young children who have attended the STEM Kids Camp; the experience flamed an interest in chemistry for Ying's 7-year-old daughter, who especially liked mixing different chemical concoctions.

Trung knows from experience the importance of meeting experts in the field who can expose young people to new ideas and inspire their passions. When he was a high school student, Trung's mom took him to meet a renowned researcher and professor of water resources engineering. After a three-hour discussion with the professor, Trung realized he wanted to spend his life learning more about water resources engineering. Now, he hopes he can help his students discover passions of their own.

"I wish I could have had that discussion with more professors — it could have given me more opportunities to think about a different kind of discipline," Trung said. "Kids can't really be passionate about something they've never seen. From our side [as teachers], we just show the option, and they should discover their passion by being exposed to those options. It's very difficult when [adults] say, 'Follow your passion,' but you don't really know: What are all the options on the table?"

This resonates with Emily as well, who dreamed of being an astronaut when she was growing up — or something where she could explore, invent, and put her love of science and math to work. But it wasn't until the seventh grade, when one of her teachers showed a video of a girl setting up a Rube Goldberg machine, a complex chain reaction that accomplishes a simple task (think the board game Mouse Trap), that Emily heard — and understood — the word "engineer." She was dazzled.

"I was like, that's a word for what I'm trying to do!" Emily said. "Most kids, when they're that young, don't think, 'I'm going to be an engineer,' because a lot of people, even adults, don't know what an engineer is or what they truly do. Kids understand what a nurse does, or a doctor, but with an engineer, kids can't really visualize that."

Introducing young people to STEM concepts before they make a college choice is critical for developing a strong pipeline of future engineers and problem-solvers across disciplines. By offering a variety of outreach opportunities targeted toward K-12 students, NDSU's College of Engineering hopes to help students explore different degree programs, pathways, and careers with confidence and enthusiasm.

"I want them to walk out thinking engineering is not a big, scary thing," Emily said. "I want them to look at something and try to figure out how it works. I want them to learn how to try, how to solve, how to troubleshoot. Even if they end up not being an engineer, I want them to learn those skills.

"Society's gotten so much better at introducing engineering to kids earlier and earlier in life. I just get really excited, because I know future generations of engineers are going to be that much better."

CITY SUPERHEROES

Trung and Ying introduced sixth through eighth grade students to civil engineering concepts, from buildings to bridges, rivers to pipelines, and more in the City Superheroes class. They began the week by simulating the formation of rivers, making channels out of sand, and creating flooding conditions to mimic the movement of water through the Red River watershed.

On the second day, the students built their own paper cities connected by roads and

NDSU professor **Trung Le** and an assistant use sandboxes to teach camp participants how to simulate the formation of rivers.

NDSU student **Emily Balluff '23** teaches camp participants how to use time-based coding commands to make their robots break dance.

bridges. Then, disaster struck; the city superheroes became the city villains. What horror befell their handcrafted metropolises, you might ask?

"Some stuff we're not proud of," Grant, a sixth grader, joked. He was referring to a contraption he and his friend Sam, also a sixth grader, had built to launch popsicle sticks at their city.

"They were very creative," Ying said, laughing. "I was very proud of them."

The class continued to build on students' understanding of city infrastructure. They learned how water flows through pipes, and on the last day, Ying explained how pipelines can accrue defects.

"Pipes can bend and become another shape. They can be dented. Chemical reactions can cause corrosion and erosion," she said, "but it can be hard to find damages."

This is where pipeline inspection gauges (PIGs) come in handy. Grant and Sam immediately dove into the construction of their own robotic smart PIGs, laying out each of the pieces and patiently following along with an instruction manual.

"Take your time," Sam said, giving advice to someone building a robot for the first time. "There's a lot of things that you don't want to mess up — say you put a part in the wrong spot, and you don't realize. You have to pay attention to which pieces are which. I mean, there could be like one thing different, and it does something completely different. You want to know what you're doing."

Trung sees immense value in giving students the chance to explore engineering-based activities beyond what they might be exposed to in everyday life, but he also sees the STEM Kids Camp as an important learning opportunity for faculty. As STEM subjects become a greater priority in K-12 classrooms, and technology evolves and becomes more widely distributed, upcoming generations will need to be taught according to their unique needs and points of view.

"We want to understand their way of interacting with the material, because they live in a very different world than where we grew up," Trung said. "We want to understand their curiosity, their viewpoint, so we can adapt and improve our future lectures, because they're going to be the people who come to our college in the next six or seven years."

ROCKIN' ROBOTS

Third through fifth grade students in the Rockin' Robots class spent the week learning the foundations of robotics and finding real coding solutions using LEGO Education SPIKE kits. Emily, who developed a passion for robotics after joining a FIRST Robotics team in high school, bubbled with enthusiasm as she described the "anatomy" of a robot.

"The circuit board acts like the brain. The code is the knowledge that's going into the brain," she said. "Then you have your actuators, or manipulators, which are your mechanical things. These are your arms and legs of the robot. The electrical system, all of those wires and everything, that's like your nervous system going through your body."

Throughout the week, the kids designed robots that could hop, dance, and do situps. By the final day, they were coding autonomous vehicles made of Legos, programming them to drive a square route around their table before racing their classmates' cars in an all-out competition — and they

Four hundred thirty students registered for STEM Kids Camp this summer, and many of them took multiple classes.

were facing some bugs.

"In engineering school, you're taught to think like an engineer, because they can't prepare us for every problem that's going to come our way," Emily explained to the class. "We need to be able to think on our feet, and using our education, go in the right direction and figure out how to solve it."

Harper, a fourth grader, watched her robot take one too many close turns and crash into a LEGO box on the table.

"It's hard to code a robot!" she exclaimed, but continued to try to adjust the speed and turns in the code.

Nearby, Nikolas and Bennett, both third graders, were rebuilding their robot for a third time, after it repeatedly turned too late, causing it to crash onto the floor. While they reconfigured their busted robot, they imagined what other kinds of robots they could one day create; Nikolas would like to make a robot that could do his homework, and Bennett would like to make a robot that could dispense infinite Oreos and money.

With their robot rebuilt, they started debugging the coding and shared their favorite parts of the week.

"We learned about how vehicles work and how they are coded. You have to be very specific about how you talk to them to get them to do stuff. We're also learning about many types of engineers," Nikolas said.

"I had a really good time, and I made some new friends," Bennett added.

Is your child interested in STEM?
NDSU's College of Engineering hosts a variety of K-12 outreach programs throughout the year. Visit **NDSU.edu/coe/outreach** to learn more.

> **"I want them to learn how to try, how to solve, how to troubleshoot. Even if they end up not being an engineer, I want them to learn those skills."**
>
> Emily Balluff '23

In the **Rockin' Robots** class, kids were assigned the role of R2-D2 or C-3PO; every R2-D2 needed to find a C-3PO to be their partner in innovation.

NITIN RAI ’23
photographed
by Ann
Arbor Miller

THE NEXT ERA OF AGRICULTURE IS AUTONOMOUS

Story by Micaela Gerhardt | Photos by Ann Arbor Miller and Emerging Prairie

As the number of farms declines and the world population grows, researchers at NDSU are exploring how artificial intelligence and precision agriculture practices can help protect resources, support farmers, and sustain the nation's food supply.

Picture this:

An autonomous drone flies over a field of crops, weaving its way through spring wheat, sunflowers, and canola. The drone is searching for weeds, using a machine learning algorithm to identify, then spot-spray, the harmful invaders, shielding nearby crops from unnecessary herbicides.

Different factors contribute to the drone's ability to distinguish pesky weeds from valuable crops. Agricultural engineers must collect thousands of big data points to train drones to respond appropriately to potential variables. *What direction will the drone be flying? What is its altitude? What time of day is it? Will there be shadows? How does the weed appear from above or at different angles?*

At NDSU, agricultural engineer Nitin Rai '23 is conducting this exact research for his dissertation. Along with a team of USDA-funded researchers led by associate professor Dr. Xin (Rex) Sun, Nitin is examining the application of drones in agriculture. He has spent the past four summers in the field collecting images and the following winters in the lab working to create lightweight computer vision models that can identify weeds while flying at high speeds. These models can be integrated with small microprocessors that communicate with the nozzle, telling it when and where to spray.

Thus far, the computer vision model Nitin manually programmed has achieved 85% accuracy in identifying five different species of weeds in two unseen locations (places the drone has never flown before) in the state of North Dakota.

"This is the pace with which technology is moving right now, and this is the future of precision agriculture," Nitin said.

At NDSU's annual Three Minute Thesis competition, where Nitin earned the title of grand champion for his presentation on weed-spotting technology, he cited research that estimates the world population will reach 9.7 billion by 2050.

"With that population growth rate, farmers are expected to use advanced technologies that are fast, reliable, and sustainable," Nitin said. "One such technology is drones in agriculture that can be used to monitor weed growth."

Weed-spotting drones are just one piece of the puzzle — AI is currently being applied to many sectors of agriculture, including poultry farming, irrigation, robotic harvesting, autonomous tractors, and more. Ag tech entrepreneur Barry Batcheller '77, '10 foresaw this rapid shift and cast a vision for a fully autonomous farm by the year 2050. That vision led to the creation of Emerging Prairie's Grand Farm Innovation Site, home to more than 450 acres of farmland designed for research, education, and testing experimental technologies, like Nitin's drones.

"Grand Farm postulates this question: What will a farm look like in 2050? It's not strictly about autonomous tractors or advanced farming practices, but it's a bigger question," Barry said. "What do you do for education on the farm? What do you do for medicine? For entertainment? For energy?"

Advancing agriculture and sustaining

GRAND FARM (pictured right) is home to more than 450 acres of farmland designed for research, education, and testing experimental technologies.

families in rural America will require attention to more than technological progress alone. As Barry sees it, addressing sociological and environmental questions will be just as critical.

"Those types of questions spur activity," Barry said. "Then people say, 'Even though I'm majoring in nursing, I have a role in that because telemedicine is involved. Even though I'm majoring in education, I have a role.' I think if you define the problem in the proper context, you create a really inclusive ecosystem of discovery. You can 'declare a major' in high technology agriculture and still encompass many disciplines of education."

He dreams of establishing the Red River Valley as the nationwide hub for ag tech advances and research that addresses these multifaceted issues — imagine a community as niche, innovative, and prosperous as Silicon Valley, but centralized in Fargo, North Dakota.

But to look toward the future, we must also examine the past. Throughout history, Barry says, technological advancements have equipped the agricultural industry to feed a growing world. The first big step was mechanization, moving from hand labor to machines like steam tractors that enabled farmers to be more productive. Then, during the Green Revolution in the 1950s-1980s, farmers utilized fertilizers and breeding strategies to maximize crops' abilities to grow.

"When the country was first settled, the majority of the population was agrarian; they farmed, and that allowed people to survive and to have food and fiber," Barry said. "Fast forward now, 200 years later, and about 1.3% of U.S. employment is comprised of direct, on-farm workers, so it's flipped completely around, and yet they produce enough food and fiber to feed this country and a good part of the world. That productivity has come about by these stages of growth."

This progress has led to the advent of precision agriculture practices, which empower farmers to maximize crop production by responding to the variability that exists within a field. Using technology to capture topography and soil properties — like salinity levels and ratios of sand, silt, and clay — allows farmers to treat each different area according to its own unique needs, Rob Proulx, agriculture technology systems specialist with NDSU Extension, explains.

"It's almost like enabling practices that were more commonplace in the horse-drawn equipment era," Rob said. "When farms were smaller, and farmers and their equipment could not get as much work done in a day, it was not uncommon to just manage your small areas in the field differently from each other, because you might get just five to 10 acres done in a day."

During the 2018-2019 academic year, NDSU became the second school in the nation to establish a four-year precision agriculture degree program. Enrolled students examine how to utilize technology to shift from macro-level farming to the micro level while still reducing the amount of time it takes to manage a field. Where research and technology are headed next, according to Rob, is making it possible for farmers to manage crops at the individual plant level with the help of AI.

But are these advancements happening too quickly? As AI makes its appearance in more and more aspects of our daily lives, whether

in agriculture or art, many people are raising ethical concerns. Nitin sees it as his role and responsibility to do as much data collection and safety testing as possible before this technology hits the market.

"A lot of testing needs to be done, especially when AI is being integrated with agriculture," Nitin said. "That's where engineers come in, because they test these technologies from all aspects to answer the most crucial question: How does the technology adapt to changing surroundings? Ultimately, because no technology is ideal, it's going to fail. We should have that kind of understanding and should equip technologies to an extent that it does not harm human life, because that's important."

Along with ethical concerns, engineers and researchers must ensure they are meeting the practical needs of producers. When Nitin and his fellow teammates presented their drone technology research at North Dakota's annual Big Iron Farm Show, they received feedback from farmers themselves.

"They would ask a lot of application-based questions, like, 'How does the speed affect in-field weed identification? Is it able to precisely spray identical looking weeds? How much herbicide savings is it going to give?' and things like that," Nitin said. "Those are other research questions that need to be answered, and that answer comes through in-field application."

In the coming decades, it is not guaranteed that farmers will be able to produce enough food to feed the peak projected population.

"The advancements we've made have been really good — mechanization, the Green Revolution, and the things we're doing today," Barry said, "but we're also in the process of questioning some of the things that can turn it around if we say, 'Gee, too much fertilizer is bad for the planet; we should stop using fertilizer,' or if we say, 'Gee, we're blowing smoke into the atmosphere and too much smoke is a bad thing; we need to cut that down.' There are forces at play that can undo some of the things that have been done, which can make it more difficult in the future to continue this curve of ever-increasing productivity."

Many farmers are also attuned to environmental impact.

"Generally, the production farmers in this country are very sensitive to environmental things," Barry said. "They take care of [the land] — it's where their livelihood takes place, so farmers are generally very good stewards, but today it's becoming an increased sensitization ... How is the agricultural footprint adversely affecting the planet?"

Barry sees a need to work proactively against these headwinds, and he believes partnerships between NDSU and the industry, including companies like John Deere and AGCO that have locations in NDSU's Research and Technology Park, will support the growth of critical research activities that will create solutions for these impending challenges.

"I think the opportunity for the University is to really bring focus on these really interesting activities and to bring business and industry in to support the growth of these activities, because clearly the industry is so interested in these things," Barry said. "People who are fortunate enough to enter the educational space today have all these really neat things to look forward to."

"What will a farm look like in 2050? It's not strictly about autonomous tractors or advanced farming practices, but it's a bigger question. What do you do for education on the farm? What do you do for medicine? For entertainment? For energy?"

Barry Batcheller '77, '10

ENERGIZED BY AN OATH

From homes that heat and cool themselves more efficiently to thermal systems that keep car batteries operating at an ideal temperature during the coldest North Dakota winters or hottest summer days, NDSU professor Adam Gladen is helping the College of Engineering become a national leader in energy stewardship.

Story by Kyle Bosch | Illustration by Leah Ecklund

I am an engineer. In my profession, I take deep pride. To it I owe solemn obligations.

Those three sentences, the opening lines of the Obligation of the Engineer, can be heard on campus every winter and spring when soon-to-be NDSU graduates join the Order of the Engineer.

The Order was formed in 1970 to foster a spirit of pride and responsibility in the engineering profession, but the idea of setting forth an ethical code can be traced back thousands of years to the Hippocratic oath.

At the core of the Obligation, and the Order itself, is the pledge of stewardship — an acknowledgment that the skills of an engineer come with an obligation to serve humanity by making the best use of the Earth's precious resources.

"We all use energy every day; no one wants to go back to the Stone Age, and we, as people, have a responsibility to be good and wise stewards of the resources we have," Adam Gladen, associate professor of mechanical engineering at NDSU, said. "Energy impacts our wallets, our environment, and our national security."

Adam's teaching and research are broadly focused on thermal energy systems, solar energy, thermal energy storage, and electrochemical systems. In the last two years, he has been awarded more than $2.24 million in research funding, including a major grant from the Department of Energy to develop a novel thermochemical adsorption material for thermal energy storage.

A breakthrough in this area could have major impacts on the amount of energy we use. Thermal energy needs for heating, cooling, and hot water make up 45% of total energy demand in commercial buildings and more than 60% in residential apartments and homes — by far the largest energy use.

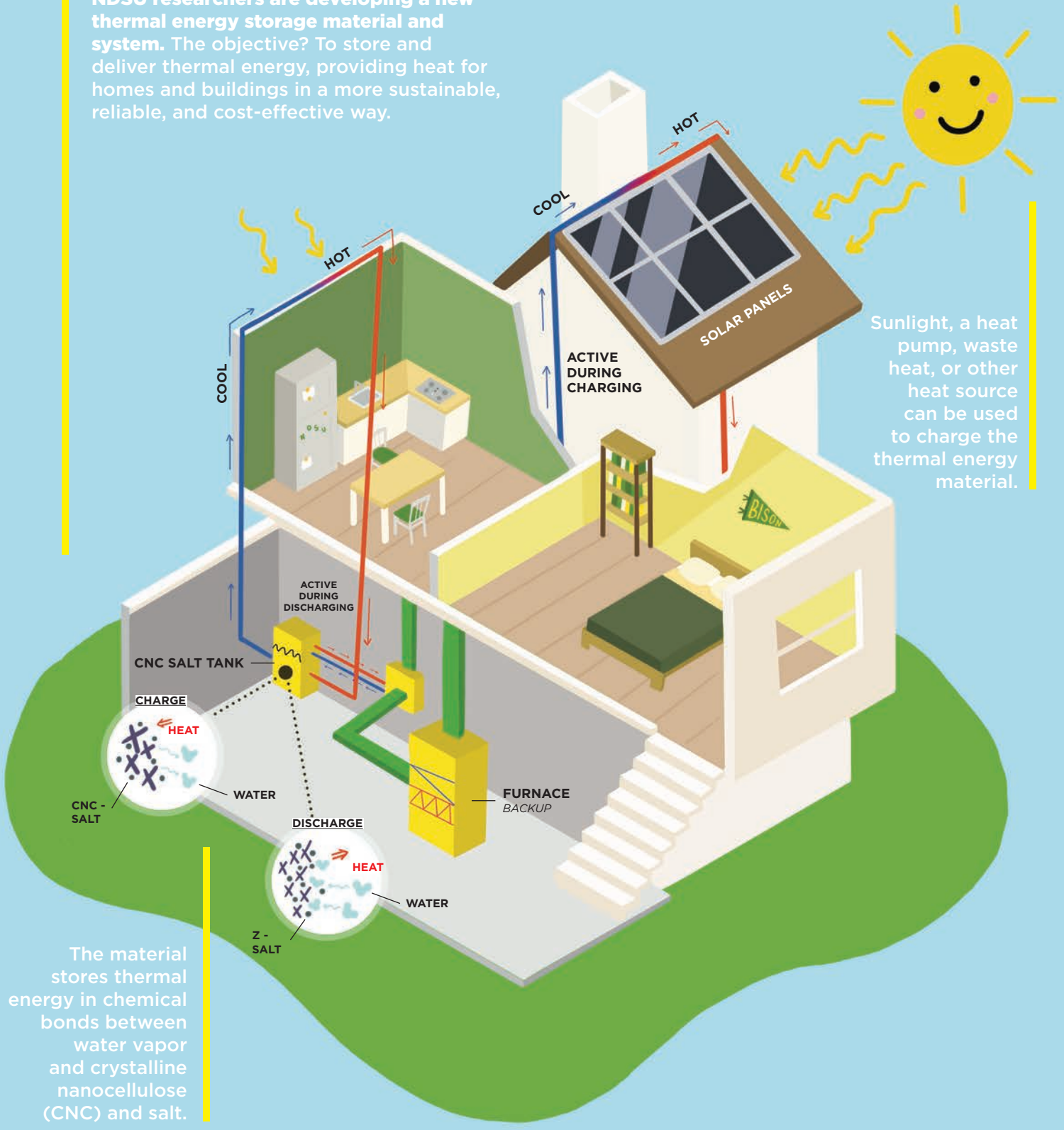
"The [research] team is looking forward to developing this new material and modeling how it will improve energy usage in buildings," Adam said. "Our long-term goal is to use this novel material in new storage systems to reduce energy usage in homes, offices, and other buildings. This can lead to significant savings for the owner, especially in states like North Dakota that have high heating loads. Eventually, we plan to use the results of the research to guide development of energy storage technology for other applications as well.

"None of these advancements would be possible without the hard work of our graduate students, undergraduate researchers, and campus collaborators," Adam added. "Our student researchers at NDSU work very hard to move the research forward."

Adam's talent extends well beyond the research bench. In 2021, he was honored for his work in the classroom, earning the department of mechanical engineering's Pi Tau Sigma Excellence in Teaching Award. Adam is also using what he learns in the lab to strengthen his classes and bring new offerings in high-demand areas like energy storage.

"I really see a strong tie between good teaching and good research. By being a better researcher, I can take those ideas and use them to strengthen my teaching in the classroom,"

NDSU researchers are developing a new thermal energy storage material and system. The objective? To store and deliver thermal energy, providing heat for homes and buildings in a more sustainable, reliable, and cost-effective way.



Sunlight, a heat pump, waste heat, or other heat source can be used to charge the thermal energy material.

The material stores thermal energy in chemical bonds between water vapor and crystalline nanocellulose (CNC) and salt.

Adam said. “I can expose our students to areas they might not even think of as mechanical engineering or energy-related research and really deepen their understanding of how important it is and how meaningful and impactful it can be.”

Because of his success as a researcher and teacher, Adam was recently named the inaugural KFI Engineers Professor of Energy Stewardship. The position is funded by a $300,000 investment from KFI Engineers with the goal of building the NDSU College of Engineering into a national leader in energy stewardship by attracting and retaining top faculty.

KFI Engineers is a 250-person process and infrastructure design firm with seven offices across the U.S. The company opened its Fargo office 10 years ago to gain access to a skilled and dedicated workforce that can be deployed nationally.

“NDSU’s College of Engineering, and its energy stewardship program, are gems,” Jim Faulconbridge ’90, professional engineer and co-founder of KFI Engineers, said. “It’s the best pathway for any kid from North Dakota, Minnesota, South Dakota, or wherever to earn an engineering degree, and anyone coming out of this program will be employable in any city in the United States, because those cities have infrastructure needs, both public and private, to support that workforce.”

Jim grew up in Mohall, North Dakota, and completed a pre-engineering program at Minot State University before transferring to NDSU. He credits his professors at NDSU, especially Sherman Goplen, for providing the tools to succeed.

“Dr. Goplen really set the table for us. He was passionate about undergraduate teaching and was very well respected for his industry experience. I didn’t really realize the quality of the faculty until I got out and listened to other people who did not have those same experiences at their schools,” Jim said.

As Jim himself can attest, quality faculty have a way of building connections with students that last a lifetime — and the best, like Sherman, have a way of continuing to teach lessons on stewardship even long after a degree is earned.

“Dr. Goplen is a tireless supporter of NDSU’s engineering program. He has his own scholarship to bring people into this program, so I think that is a good model to emulate,” Jim said.

Stewardship is about more than just the management of Earth’s resources. The concept of stewardship can be applied to many areas, including philanthropic support to the University. Every day, NDSU alumni are answering the call to care for a place that impacted their lives in countless ways and are using their time, talent, and treasures to propel NDSU to new heights.

As the interim dean of the College of Engineering, Alan Kallmeyer is keenly aware of the finite nature of many resources within a university setting. Alan has worked closely with Jim to maximize the impact of KFI’s philanthropic investment. In addition to providing funding for Adam’s research, the department has also hired a new professor of practice specializing in thermal fluid sciences and energy stewardship.

Professors of practice focus on undergraduate teaching and bring important industry experience to provide students with real-world examples of the theory taught in class.

“Jim knows the value of strong faculty providing our students a great experience,” Alan said. “By investing in our energy stewardship initiative, we’ll be able to build a national reputation in this area and develop new courses and labs that will enhance our educational offerings and give our students the skills companies need.”

The push to create the energy stewardship program is part of a larger effort in the College of Engineering to grow teaching and research in areas of high economic importance to the state, region, and world. Other high-impact growth areas include precision agriculture and autonomous systems, artificial intelligence and cybersecurity, advanced infrastructure, and entrepreneurship and commercialization of new technology.

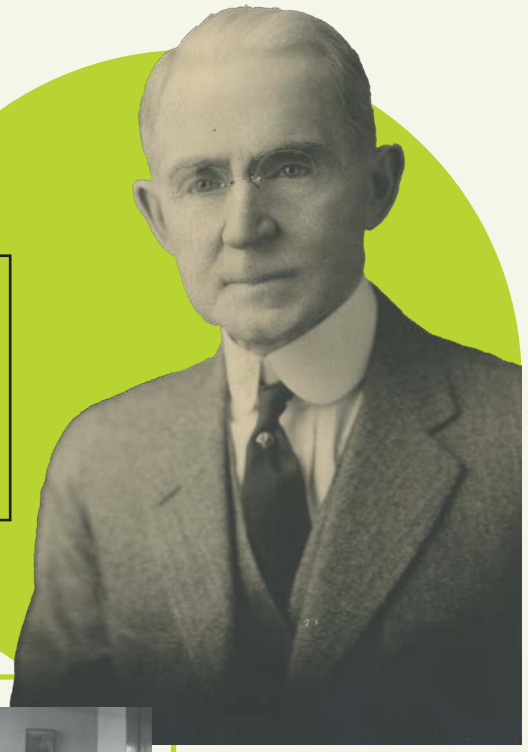
The hope is that KFI’s investment to kickstart the energy stewardship program will serve as a model for others, spurring more investment in the College of Engineering and NDSU. For Adam, it will serve as another way to live out the Obligation’s call to stewardship: wisely using the resources he has been given to help preserve Earth’s resources for generations to come while teaching new generations of NDSU engineers to do the same.

> “WE ALL USE ENERGY EVERY DAY; NO ONE WANTS TO GO BACK TO THE STONE AGE, AND WE, AS PEOPLE, HAVE A RESPONSIBILITY TO BE GOOD AND WISE STEWARDS OF THE RESOURCES WE HAVE.”
>
> ADAM GLADEN

CURIOSITIES

Story by Micaela Gerhardt | Photos from the NDSU Archives

1892 EDWARD S. KEENE



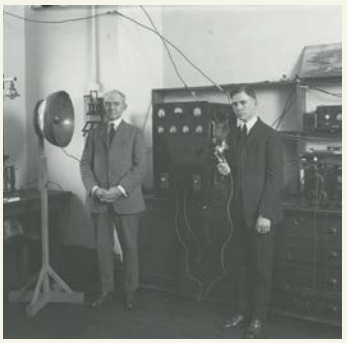
Edward S. Keene's arrival in 1892 marked the beginning of engineering at NDSU (then North Dakota Agricultural College). He was hired as the head of the department of physics and engineering and taught mechanic arts shop classes in the engine and boiler house of the University's heating plant. When a new engineering building opened its doors on the rolling prairie in 1907, the increased space created an opportunity for NDAC to offer civil engineering as a complete course of study. A few years later, electrical engineering was offered as a complete course as well.

Edward was an innovator at heart. He organized the School of Mechanic Arts as the educational unit for military training on campus, serving as captain alongside two other instructors who served as lieutenants. The first detachment of soldiers entered service during World War I, and a second detachment of 500 men had not yet completed their training when the armistice was signed.

Edward founded NDAC's drama club and directed its first play. Together with his students, he also established the University's first radio station, WPAK, using a 50-watt homemade transmitter, with programming that included play-by-plays of highly anticipated basketball games.

In 1918, Edward was named dean of the School of Mechanic Arts. He later served as acting president of the University, then resumed his deanship when a new president was appointed. When Edward resigned after more than 30 years of teaching and service to NDAC, enrollment had grown to 134 students in the School of Mechanic Arts.

Edward, the first professor of engineering at NDSU, in his office



Pictured (left) with a student assistant in the University's first radio lab (WPAK, 1924)

Edward (right) organized military training on campus

To see more photos of the early days of NDSU engineering, scan the QR code or visit "Curiosities: Edward S. Keene" at **NDSUFoundation.com/magazine**.

NDSU FOUNDATION

McGovern Alumni Center
North Dakota State University
PO Box 5144
Fargo, ND 58105

JOIN THE FUN

Get involved! Celebrate and connect with NDSU alumni and friends at upcoming events. We hope to see you!

2023

NDSU Homecoming Parade & Bison Bash
Friday, Sept. 29

Bison Bidders Bowl
Saturday, Sept. 30

Harvest Bowl Awards Dinner
Friday, Nov. 10

NDSU Giving Day
Tuesday, Nov. 28

2024

Meet Us in Florida
Saturday, Feb. 3

Meet Us in Arizona
Thursday, Feb. 22 - Friday, Feb. 23

Evening of Distinction
Thursday, April 25

Meet Us in Bismarck
Wednesday, June 5 - Thursday, June 6