

Growing ND capacity for research

At ND EPSCoR, part of our mission has been to help broaden and diversify ND's science, technology, engineering, and mathematics (STEM) workforce pathway from elementary through graduate school and to support and grow STEM research capacity and competitiveness at institutions of higher education across the state.

The research, education, and outreach potential of the recent ND EPSCoR awards made to faculty on 10 campuses is impressive. Each institution, from primarily undergraduate (PUI) to master's college/university (MCU), tribal college/university (TCU) or research university (RU), has a unique mission. These funds help support the progress of each campus and contribute to the growth of the entire higher education enterprise in the state.

Why is it important?

- Increased capacity and competitiveness are essential for students. Research shows that early exposure to STEM, as well as hands-on research at the undergraduate level, has a profound impact on students' awareness and interest in STEM careers. Students throughout the state receive support as research participants of the NSF Track-1, from the distributed Research Experience for Undergraduates (REU) program, Graduate Student Research Assistantships (GSRA), Doctoral Dissertation Assistantships (DDA), or Students in Technology Transfer and Research (STTAR).

Also, through ND EPSCoR's Nurturing American Tribal Undergraduate Research and Education (NATURE) programs, over 2,700 high school and undergraduate students have been given the opportunity to participate and explore STEM topics of interest.

The prospect of exploring new ideas or conducting quality research related to personal interests is a significant builder of STEM awareness, attraction, and perseverance in a discipline. Collectively, these

programs provide critical mentoring, financial support, and practical experiences that help prepare students for future STEM careers.

- Increased capacity and competitiveness are essential for faculty. Two examples from the recent NSF Track-1 cooperative agreement illustrate how faculty are impacted. Collaborations across disciplines have allowed several of the Center for Regional Climate Studies (CRCS) researchers to pursue new funding sources. Other efforts have resulted in developing research collaborations between researchers at the various ND institutions as well as with CRCS stakeholders, enhancing research/educational opportunities at both their own campuses and across the state and region.

The Center for Sustainable Materials Science (CSMS) has been involved in several collaborative efforts with other researchers in the state and across the nation. Thanks to the creation and transfer of this new knowledge, there have been fundamental technology developments, from patents to new industry partnerships.

The need nationally and in North Dakota for a well-trained STEM workforce continues to grow. By engaging more of our "home-grown" talent, we have the opportunity to expand capacity and competitiveness, strengthen our local communities, and enhance the economy of ND. The result? A better-prepared workforce, increased growth of new knowledge into practice, and enhanced quality of life for all ND citizens.



Best wishes for the holidays!

Kelly A. Rusch, Ph.D., P.E., BCEE
ND EPSCoR Executive Director

A national EPSCoR perspective

In late October, several individuals attended the National NSF EPSCoR Conference in South Carolina. A few faculty researchers from NDSU and UND, three State Steering Committee members, and the ND EPSCoR principal and co-investigators attended the conference, which focused on EPSCoR jurisdictions developing a better transdisciplinary approach to generate innovative solutions. The attending NSF EPSCoR jurisdictions had the opportunity to examine barriers and share best practices for building partnerships across disciplinary boundaries.

Three legislators who serve on the ND EPSCoR State Steering Committee attended the conference: **Senator Ray Holmberg**, **Senator Merrill Piepkorn**, and **Representative Corey Mock**.

Senator Holmberg (right) said, “The passion, particularly of the young participants, towards research was impressive. It confirmed the importance of supporting research in ND because it will impact the students’ future role in discovery.”

“My goal at these meetings is to see what information I can bring back to ND,” said Piepkorn (bottom right). “I believe in doing research because it advances our state, it brings faculty and students to our state, and it helps support industry that makes an impact across ND.”

“It was really important for the three legislators to learn and understand how important EPSCoR research is to our state,” Piepkorn added. “When funding requests come in, we now have a better viewpoint and know some of the history. Years ago, we couldn’t have imagined the research we’re doing now at the colleges and universities across North Dakota.”

“We’ll use this information to work more effectively within the state, helping to support and advance research,” he said. “The research is key to developing new practical applications that impact the workforce and industry. We need to continue to fund research and collaborative efforts if we want to grow and sustain our state’s economy.”



Culture in the classroom

At Cankdeska Cikana Community College (CCCC), the motto is *Think Dakota, Live Dakota*. Educators try to connect course content to Dakota culture and values. Associating the culture with content is a way to activate students’ prior knowledge and connect new ideas to information the students already find familiar, according to current research.



Parker, left, discussing teaching philosophy with Megan Even, ND EPSCoR administrative coordinator.

Activating a student’s prior knowledge is a common teaching method, but when done in a culturally relevant way, the method has a double purpose of reaffirming cultural identity. ND EPSCoR’s NATURE programs also approach teaching in this way.

But how is the method done in practice?

Mike Parker, a researcher for CSMS and instructor at CCCC, has found that Dakota values fit nicely into the classroom context. The Dakota values of honesty and integrity, for example, can be invoked when setting deadlines for assignments, and the Dakota value of responsibility can be invoked when discussing the importance of attending classes.

Practicing the Dakota values himself is a good way to build trust with his students, Parker noted. “Humility was important to build trust,” he said, adding that his classroom is an environment where he and his students “learn together.” Parker has also found that the smaller class sizes have helped him build trust with his students. He is able to speak one-on-one with students and understand their life situations better than if he were teaching a large lecture group.

Patience is another a virtue that Parker uses; a student may not connect to a course at first, but Parker has seen students “grow into the connection between course content and their traditional values.”

Engaging students in culturally relevant ways is a key component of ND EPSCoR's mission. Awareness and support of students' culture enhance interest and perseverance in their chosen discipline, creating a positive impact for students and for those who build the learning environment.

Creating value from byproducts

Academic research may be at the instigation of an industry or commercial need, but often there is freedom to explore and develop new ideas. **Niloy Chandra Sarker**, past CSMS researcher and May 2019 doctoral graduate at NDSU in Agricultural and Biosystems Engineering, has had the experience of exploring novel biobased materials in his research efforts.

"I've had the opportunity to work on three different wheat bran projects with CSMS," he said. "Wheat bran is a ND agricultural byproduct, but it has great potential for multiple value-added uses," Sarker said. "Right now, the bran is very cheap, and often thrown away as a byproduct," he explained. "If we can help make it more valuable with these other uses, it benefits the farmers, as well as the environment."



In the lab, Sarker (above) has worked with arabinoxylan, a type of cellulose that is found in the outer shell or bran of cereal grains such as wheat. In collaboration with CSMS researchers **Khwaja Hossain**, (professor of Biology at Mayville State University), **Chad Ulven**, (professor in Mechanical Engineering at NDSU), and **Mohiuddin Quadir** (assistant professor in Coatings and Polymeric Materials at NDSU), Sarker has used the cellulose to develop a nanoparticle-sized biopolymer that can deliver nutrients or medicines to plants. "We're using plants to help plants," Sarker said. "Are there better ways to deliver nutrients to plants, or medicines

to people? These nanocarriers may change how nutrients are delivered since they can target certain types of cells."

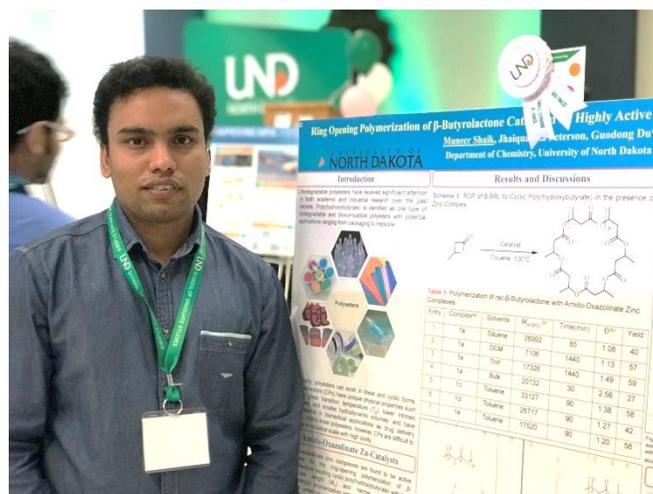
A second use of the wheat bran is in biochar. "Our research shows the biochar could potentially become a treatment for wastewater, removing oil particles and heavy metals," Sarker said. "Finally, we've been able to experiment with bran biochar as a replacement for fly ash to create a 'self-healing' concrete material."

With the biochar, the water treatment and concrete research is in the early stages, but the concept has been proven successful at the bench scale. The next step will be added research to see if it works on a larger scale. The challenge many researchers experience in proving an idea is that while it can be produced in minute quantities in the lab, the materials don't always perform the same way when tested in larger batches.

Throughout his research, Sarker has targeted replacing synthetic materials with biocompatible materials. "If we can help make ND agricultural products more valuable while benefitting the environment at the same time, that's a positive change for everyone," he said. "We're now ready to take the next step: making our lab research scalable so it can be responsive to industry uses."

Finding a different path to a biodegradable polyester

Polymers are used in a host of materials around us, from tablespoons to satellites. Most polymers are made from petroleum-based monomers (the foundational building blocks of polymers). These petroleum-based polymers have many useful properties, but are non-degradable at the end of their useful lives, creating challenges for disposal, according to **Muneer Shaik** (below presenting at a conference), CSMS researcher and graduate student in Chemistry at UND.



As part of the Center for Sustainable Materials Science (CSMS) effort across ND, researchers are looking to find bio-based replacements for the petroleum and to find materials that will bio-degrade. One of CSMS' projects is to find other molecular building blocks that can be used in novel ways.

Polymers are shaped in various forms from a "figure 8" to stars to cyclic or ring-shaped. Researchers at UND have taken a closer look at one specific shape of macromolecule—cyclic—which is intriguing since it has different properties from the more linear polymers and has not been as thoroughly studied.

Developing synthetic cyclic polymers that are pure with high molecular weight is a difficult and complicated process, Shaik said. The difficulty has limited the applications for cyclic polymers, although they seem to have some positive characteristics. Shaik's research under the direction of his advisor **Guodong Du**, CSMS researcher and UND associate professor in Chemistry, focused on using zinc complexes as the catalyst in synthesizing the cyclic polymers. Early results of his experiments show that by using the zinc complexes, the chemical reaction helps activate the bio-based lactone monomers. The end result is a well-defined cyclic polyester that is also biodegradable.

As with any early-stage research, the first step is determining the possibility of developing a bio-based cyclic polymer. Now that has been accomplished, the research team can turn their attention to applications of this innovative material.

The distributed REU experience

"It's opened my eyes to science," said **Creighton Pfau**, REU awardee and senior at Mayville State University. "It's been really fun. It's helped me see how expansive biology and chemistry can be, and areas where they overlap. Because of the experience these past two summers, I want to do something in the medical field. I'm preparing for the Medical College Admissions Test (MCAT) and going to do some job shadowing in the near future. Right now I think I'd like the healthcare side, but if the research area stays interesting, I could definitely see myself doing that too."

The benefit of Pfau's research experience has been trying to solve problems in the real world. "I don't have a ton of background in chemistry," he said. "My focus has been more biology, and I've appreciated getting to learn it with real-life examples, not just a textbook." His first summer was spent working with metformin, trying out plant-based nanocarriers for various molecules. In 2019, Pfau focused on wheat bran research, joining a

team at Mayville headed by **Khwaja Hossain**, CSMS researcher and professor in Biology.

According to Pfau, wheat bran is a byproduct of wheat milling, often considered waste with a fraction of the value of wheat. But in this research, the bran has proven to be an interesting and readily available source material. Pfau has worked on three applications with the wheat bran: as a component in concrete, as a treatment for water, and for oil spill removal. To change the wheat bran into usable material for the research, the bran is heated to 500°C for three hours in a pyrolysis process, which creates biochar. This material is then used as a component for the various applications.

The results of Pfau's research indicate interesting processes. At this point, the concrete is not quite as sturdy as standard concrete, but different curing methods may lead to different results. As a source of water treatment, the biochar was able to pull out barium while leaving healthy micronutrients behind. When tested as a means of cleaning oil spills, the biochar was able to absorb about 2.5 grams of oil per gram of biochar.



Khwaja Hossain, left, with Creighton Pfau, right.

"I would not have had the opportunity to do this kind of research without the REU funding," Pfau said. "It's given me a great experience. Plus the REU is flexible, so I could continue my research this past summer while participating in sports programs. I'm grateful for that."

His mentors have also played a key role in his experience. "Dr. **Niloy Sarker**, who just completed his Ph.D. from NDSU [see article on p. 4] and worked in collaboration with Dr. Hossain, taught me about the research projects and how to conduct the experiments," Pfau said. "He answered a lot of my questions, so I've learned because he's a great teacher."

Dr. Hossain was very involved and helped me learn about biology. It's been fun and very interesting."

"I don't think many people have the opportunity for an REU," Pfau said. "It's a great chance to see how what you learn in school can be used in the real world, and I'm very grateful to have had the experience."

EPSCoR support for ND K-12 instructors

Don't forget that the STEAM Energy Teacher Professional Development Module, an enroll-anytime self-paced online course, is now open:

<https://register.und.edu/learning/jsp/session.jsp?sessionId=PDE.20.0522&courseId=TL.ONL.SE&categoryId=10062>

Once enrolled, participants have 60 days to complete the modules. These modules were developed with funding from North Dakota's current National Science Foundation (NSF) EPSCoR RII Track-1 cooperative agreement (INSPIRE-ND).



This three-module course will explore aspects of STEAM (science, technology,

engineering, arts, and mathematics) instruction through an integrated investigation of sustainable cities.

Participants will imagine, research, design, and build their own sustainable city while considering how this integrated curriculum may be effectively taught in their own classrooms. Each module has a specific content focus that participants will engage with through both a learner and teacher lens, allowing them to develop a deeper understanding of energy sources and consumption, city design, geography, climate, and population.

As a part of the INSPIRE-ND financial support, the first 25 Science teachers in ND who successfully complete this course will be reimbursed for the total cost of the course (and receive information to promote STEM instruction in their classroom). Please contact the instructor, **Ryan Summers**, EWD researcher and assistant professor of Science Education at UND, at ryan.summers@und.edu or call 701-777-3144 for more information.

Activities of note

Alex Wittenberg, CRCS researcher and NDSU graduate student in Agronomy, was awarded third place in the Bioenergy Systems division of the Graduate Student Oral Presentation Competition at the 2019 American Society of Agronomy annual meeting held in San Antonio, Texas, Nov. 10-13. His presentation, *Sowing Date Affects Winter Camelina Stand Establishment* outlined preliminary research on the effect of fall sowing dates on fall stand establishment, reduction in residual soil nitrate levels in the fall, and subsequent grain yield of winter camelina. His advisor is **Marisol Berti**, CRCS researcher and professor in Plant Science at NDSU.

David Franzen, CRCS researcher and professor and Soil Science specialist for NDSU Extension, also presented a poster that was a collaboration with **Marisol Berti**, on the *Increase in Non-Exchangeable Ammonium after Cover Crop Rye and Forage Radish* at the 2019 American Society of Agronomy annual meeting.

At the Association for the Advancement of Industrial Crops 2019 annual meeting in Tucson, Arizona, Sept. 8-11, **Alex Wittenberg** received the Best Student Oral Presentation award in the Oilseeds division with his presentation *Fall Sowing Dates in Camelina Affected Plant Density*.

Chad Ulven, CSMS researcher and professor in Mechanical Engineering at NDSU, presented on *Fiber Processing and Products*, uses and challenges for hemp stalk, at the Northern Hemp Summit held November 19-20, 2019 in Bismarck, ND.

Dean Webster, CSMS lead and chair of Coatings and Polymeric Materials (CPM) at NDSU, will be a plenary speaker at the Waterborne Symposium 2020, presenting *Towards Sustainability in Coatings Technology: Progress, Opportunities, Barriers*. The Symposium, to be held Feb. 16-21 in New Orleans, is a technical forum for environmentally friendly coatings technologies.

Aaron Kennedy, CRCS lead and associate professor in Atmospheric Sciences at UND, presented *In-Situ and Remote Sensing of Blowing/Falling Snow: A Summary of Ongoing and Upcoming Projects at the University of North Dakota* at the Northern Plains Weather Workshop at St. Cloud State University, October 24, 2019.

Andriy Voronov and **Zoriana Demchuk** presented *Versatile Monomer Platform for Plant Oil-based Latexes* at the EC Technology Forum-Biobased Coatings, held October 21-22, 2019 in Berlin, Germany.

Andriy Voronov, CSMS researcher and professor in CPM at NDSU, and **Zoriana Demchuk**, CSMS researcher and CPM graduate student, presented *Plant-Based Renewable Latexes for Coatings Applications* at the US Biobased Coatings Summit 2019 held November 13-14, in Dallas, TX.

Ghasideh Pourhashem, CSMS researcher and assistant professor in CPM at NDSU, and **Na Wu**, CSMS post-doctoral researcher in CPM, presented *Upgrading Biorefinery Lignin to Specialty Polymers: Environmental Performance and Economic Feasibility* at the 2019 Bioenergy Sustainability Conference, held October 21-22, 2019 in Nashville, TN.

Ramsharan Pandey, CSMS researcher and NDSU CPM doctoral graduate research assistant, along with co-authors and CSMS researchers, **Ghasideh Pourhashem** and **Dean Webster**, also presented a poster, *Life Cycle Analysis of a Biobased Resin: A Case Study on Acetoacetylated Lignin Resin*, at the 2019 Bioenergy Sustainability Conference.

Jordyn Berg, CSMS researcher and Chemistry undergraduate, along with co-authors **Jessica Emond**, **Lacy Lilleboe**, **Bin Yao**, **Audrey LaVallie**, **Surojit Gupta**, and **Alena Kubatova** (all UND), presented a poster, *Investigation of Lignin Solubility in Acetone: Water Mixtures at Various Solvent Ratios*, at the Undergraduate Research in the Molecular Sciences Conference, October 25-26, at Moorhead State University, Moorhead.

Doctoral Dissertation Assistantship (DDA) publications

Weigh-In-Motion System in Flexible Pavements Using Fiber Bragg Grating Sensors Part A: Concept by **Mu'ath Al-Tarawneh** and his advisor **Ying Huang** (NDSU) along with Pan Lu and Raj Bridgelall, in IEEE Transactions on Intelligent Transportation Systems, October 2019, 1-12, DOI: 10.1109/TITS.2019.2949242

Funding opportunities

NSF Track-2 funding deadlines:

EPSCoR Research Infrastructure Improvement Program: Track-2 Focused EPSCoR Collaborations (RII Track-2 FEC) **NSF 20-504**.

Letter of Intent Due Date (required): by 5 p.m. submitter's local time on **December 20, 2019**

Full Proposal Deadline: by 5 p.m. submitter's local time, **January 24, 2020**

- There is a limit of a single proposal from each submitting organization.
- Each proposal must have at least one collaborator from an academic institution or organization in a different RII-eligible EPSCoR jurisdiction as a co-Principal Investigator (co-PI).

More information at the ND EPSCoR website or:

<https://www.nsf.gov/pubs/2020/nsf20504/nsf20504.pdf>

NASA FY2020 CAN Solicitation

In response to the **FY 2020 Cooperative Agreement Notice (CAN) solicitation**, North Dakota NASA EPSCoR is soliciting research proposals from faculty at **Affiliate Institutions** specifically designed to promote and expand NASA research in North Dakota.

One proposal will be selected by ND NASA EPSCoR for full submission for the CAN.

Details and guidance for pre-proposals can be found on the ND NASA EPSCoR website here:

<http://blogs.und.edu/jdosas/2019/12/nd-nasa-can-fy2020-announcement-rfp-2/>

Pre-proposal deadline: must be submitted to ND NASA EPSCoR by **Noon, January 13, 2020**.

Following preliminary proposal selection by ND NASA EPSCoR, the selected PI must submit an NOI.

NOI deadline: January 24, 2020

Full proposal deadline: March 6, 2020.

NSF Track-4: EPSCoR Research Fellows:

The RII Track-4 Fellows program **NSF 18-526** provides an opportunity for non-tenured faculty to spend extended time at premier research facilities. The fellowship period may be used to initiate new or expand existing collaborative relationships, or to make use of unique equipment not available at the PI's home institution. Any research topic eligible for consideration under NSF's policies will be considered for support. The fellowship host site may be an academic, governmental, commercial or non-profit research facility within the United States or territories.

Deadline: 5 p.m. submitter's local time on **March 10, 2020**.

Eligible PIs employed by degree-granting institutions of higher education must hold a non-tenured faculty appointment. RII Track-4 awards will be made as standard grants, not to exceed \$300,000 or 24 months in duration. Only single-PI proposals will be considered, with a limit of three proposals per

institution (work with your sponsored programs). For more details, please see the program solicitation: <https://www.nsf.gov/pubs/2018/nsf18526/nsf18526.htm>

Department of Energy - Office of Science: Building EPSCoR-State/National Laboratory Partnerships

The U. S. Department of Energy's EPSCoR program is receiving applications for building EPSCoR-State/DOE-National Laboratory Partnerships **DE-FOA-0002215**. These partnerships are to advance fundamental, early-stage energy research collaborations with DOE national laboratories. (Information on DOE National Laboratories at <http://www.energy.gov/about-national-labs>.) Participation by graduate students and/or postdoctoral fellows is required. Junior faculty from EPSCoR jurisdictions are encouraged to apply. The utilization of DOE user facilities is encouraged. Applicants are advised of areas of additional interest: Quantum Information Science, Microelectronics, Data Science/Machine Learning/Artificial Intelligence, Energy Storage, and Plastics Recycling.

For more information, the link to the grant is: <https://www.grants.gov/web/grants/view-opportunity.html?oppld=322933>

Pre-application deadline (limit of 3 per institution): January 16, 2020

Deadline for applications: 5 p.m. (submitter's local time) **March 27, 2020**

Some campuses may have an earlier pre-submission process—check with your sponsored programs office.

EPSCoR Workshop Opportunities Program

EPSCoR is designed to fulfill the mandate of NSF to promote scientific progress nationwide and welcomes proposals for workshops in **Solicitation NSF 19-588**.

These workshops focus on multi-jurisdictional efforts of regional to national importance related to EPSCoR's goals and NSF's mission. For more information, please see the RFP:

<https://www.nsf.gov/pubs/2019/nsf19588/nsf19588.pdf>

Upcoming events

- **ND EPSCoR Annual State Conference:** April 21, 2020, at the Alerus Center, Grand Forks, ND; Registration opens January 13, 2020.

Updates from ND EPSCoR State Office

Welcome the new STEM manager

*By Jean Ostrom-Blonigen (right)
State Project Administrator*

Please join me in welcoming ND EPSCoR's new STEM Manager, **Shireen Alemadi** (below, right). Originally from Fargo, with a Master's Degree in Biology, Shireen taught biology courses and led STEM outreach and engagement programs at Minnesota State University Moorhead (MSUM) for 10+ years. She was also the Director of MSUM'S College for Kids & Teens program and SCRUBS Camp, serving almost 2,000 K12 students in 2019.



In her ND EPSCoR role, Shireen will provide STEM support throughout the K-Ph.D. pathway, including professional development for K-12 teachers and post-secondary students and faculty.

Shireen's initial assignment is to visit with faculty and staff at each of the 11 ND EPSCoR-participating institutions to learn more about their unique STEM needs. Shireen will also oversee ND EPSCoR's Students in Technology Transfer and Research (STTAR) summer internship program for post-secondary students working at ND STEM companies. Look for more information about the 2020 STTAR program in January's newsletter.

If you're interested in meeting with Shireen when she's on your campus, please reach out to her at shireen.alemadi@ndus.edu or 701.231.8264.

NATURE Sunday Academy sessions

Sunday Academy (SA) is a program offered through NATURE, helping Native American students in grades 7-12 develop an interest in STEM disciplines. SA sessions rotate to the tribal college campuses.

For more information, contact **Scott Hanson**, NATURE coordinator at scott.martin.hanson@ndus.edu.

Senses and Perception in Nature developed by **Mafany Ndiva Mongoh** (SBC-CSMS researcher and NATURE site coordinator)

January 12, 2020 Topic for all sites

Water is Life led by **Ali Alshami** (UND-ND EPSCoR Emerging Areas and Translational Seed Awardee)
March 1, 2020 (SBC)

What Lives in Wetlands? led by **Jon Sweetman** (NDSU)
March 1, 2020 (TMCC)

Winter Weather led by **Aaron Kennedy** (UND-CRCS co-lead/researcher)
March 1, 2020 (UTTC)

Oxygen Sensing in Water led by **Julia Zhao** and **Xu (Steve) Wu** (both UND)
March 1, 2020 (CCCC)

Synthesis of Gold Nanoparticles led by **Alex Parent** (NDSU-CSMS researcher)
March 1, 2020 (NHSC)

Stay in touch

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- Prior newsletters, http://bit.ly/EPSCoR_Newsletters
- Submit stories to joyce.eisenbraun@ndus.edu, please complete: <http://bit.ly/2m43Eh7>
- To be added to the newsletter mailing list, please email ndepscor@ndus.edu, subject line: newsletter.

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