



FISCAL YEAR 2015 ANNUAL REPORT

NDSU OFFICE OF RESEARCH AND CREATIVE ACTIVITY

NDSU NORTH DAKOTA
STATE UNIVERSITY



**RESEARCH ACHIEVEMENTS OF STUDENTS,
FACULTY AND STAFF AT NDSU SPAN
MANY AREAS. THIS REPORT PROVIDES
A SNAPSHOT OF THESE ACHIEVEMENTS.**

To delve deeper, scan QR codes for an expanded view of NDSU research,
or visit www.ndsu.edu/research.

LAYING A FOUNDATION FOR TRANSFORMATIVE RESEARCH AND ENHANCED SCHOLARLY ACTIVITY

Research provides opportunities to solve challenges, to foster growth and to engage in activities that help communities, individuals and businesses reach their goals.

The national research landscape once resembled silos where those studying specific areas of research concentrated primarily on a single topic in their discipline. The challenges facing states and communities, as well as the nation, have changed the landscape. This change results in major funding opportunities for teams of researchers across many disciplines who work together to solve grand challenges.

At NDSU, we are laying the foundation to engage in transformative research. While research in specific areas continues all across campus, faculty and student researchers are working to generate broad proposals with teams that may include engineers, plant scientists, chemists, social scientists, biologists, environmental scientists, health researchers and many, many more.

The strategy emphasizes three areas that both build on the strengths of the university and have relevance to the lives of the citizens of North Dakota. The areas include: Food Systems and Security; Healthy Populations and Vital Communities; and Sustainable Energy, Environment and Societal Infrastructure. This approach to lay the groundwork for future success complements rather than takes the place of current research. The focus is to build upon the research strength currently at NDSU, while moving forward to encourage a critical mass of expertise and opportunity in these areas.

NDSU remains a student-focused, research university. Benefits of providing undergraduate research opportunities are clear and include: Enhanced leadership and communication skills, greater understanding of science, growth in creative thinking ability, and building skills employers seek such as problem-solving, innovation, critical thinking, analytical reasoning and collaboration. Students participate annually in NDSU EXPLORE and in a campuswide Innovation Challenge to gain experience in research and entrepreneurship. NDSU students participate in Undergraduate Research Day at the state Capitol, meeting lawmakers and sharing the excitement generated by their research experiences.

North Dakota EPSCoR, a program of the North Dakota University System, continues to enhance research infrastructure in the state, in support of STEM programs for K12, opportunities for underrepresented groups in the STEM pipeline, support of

workforce development, and research opportunities for Tribal Colleges, primarily undergraduate institutions and research universities. ND EPSCoR, with offices at NDSU and at UND, is funded by the National Science Foundation and the state of North Dakota.

NDSU faculty and students also exhibit sustained exemplary scholarly work, resulting in 20 National Science Foundation CAREER awards since 1996, a Young Investigator Award in FY15, and other student scholarship achievements. Information about these successes is included in this report.

Externally, we welcome the opportunity to work with business and industry, and there are various ways to maximize research partnerships with NDSU, whether through sponsored research, student involvement or other innovative mechanisms. We've streamlined processes to work with business and industry and designed template agreements for students choosing to work with companies on projects for academic credit, enabling students to select how they prefer to share and protect their discoveries.

By the numbers, we have experienced continued growth in research. For FY15, we noted 42 new invention disclosures, one new start-up company and 77 new agreements to license technology through the NDSU Research Foundation, which set a record in licensing revenue of more than \$2.5 million in FY15. National Science Foundation statistics show total research and development expenditures of \$154.4 million at NDSU for FY14, the most recent year available for national comparisons.

All areas of campus contribute to our continued success. Thank you for your interest in research and creative activity at NDSU.



Dr. Kelly A. Rusch
Vice President // Office of
Research and Creative Activity



CALL IT THE “YOU SNOOZE, YOU LOSE” EFFECT

“The early bird gets the worm” sometimes means being first increases the chance of success. But international research by Timothy Greives, Ph.D., assistant professor in biological sciences, discovered something else in research results that received [global](#) attention. Results of the study of songbirds published in the journal, *Functional Ecology*, provide insight into the evolution of daily rhythms driven by animals’ body clocks. For some birds in the study, sleeping in meant they found more birds in their nests that they did not father. Researchers from the U.S., Germany, United Kingdom, Italy and the Netherlands conducted the study.

ARMS FOR JAMESON

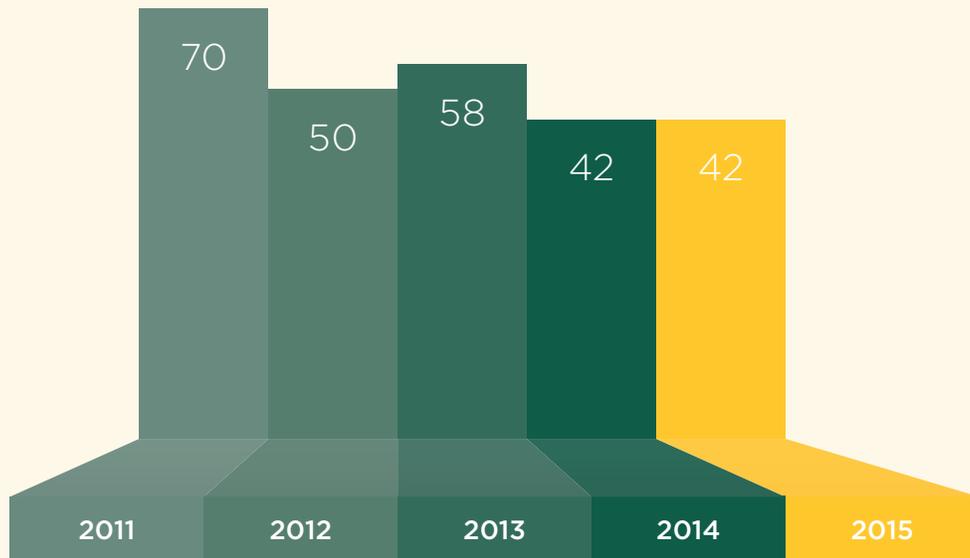
Students in an engineering class of David Wells, Ph.D, professor, developed an idea and made it personal. Pediatric prosthetic arms can carry a significant cost for each new device needed as a child grows. A team of NDSU students developed a cost-effective myoelectric prosthetic arm, producing it on a 3-D printer.



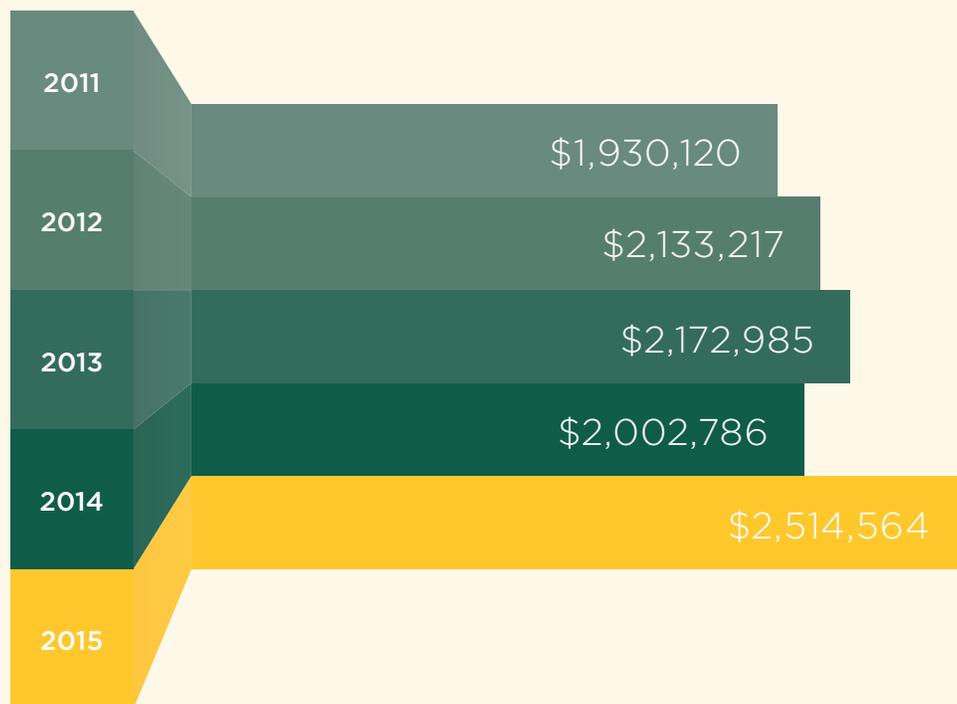
The scale of the arm can be adjusted, which means the arm can be reprinted to fit as the child grows. Wells knew exactly who might be able to test the group’s prototype. His niece’s son, Jameson, was born without lower arms and hands and the family is testing a prototype. Students and graduates who participated in the initial project include senior Cooper Bierscheid and graduates Andrew Dalman, Tyler Skeate and Michael Walmsley.

The “Truly Affordable 3-D Printed Prosthetic Arm” won an [OZY Genius Award](#). Bierscheid, a manufacturing engineering major from Watertown, South Dakota, wrote the competition entry and formed a start-up company called [Protosthetics](#), which was featured at the [State of Tech 2015](#) conference in Fargo and in Emerging Prairie. The concept received first place in the [Spark Your Startup](#) Business Pitch contest and won a poster presentation at [NDSU EXPLORE](#), an event highlighting undergraduate research. The project also was featured in [Fargo Monthly](#). In 2016, Bierscheid is participating in a medical mission trip to Haiti. He will have an opportunity to see how the 3-D printed arms they are developing might be used globally.

INVENTION DISCLOSURES



LICENSING INCOME





BUGS USED TO HELP FIND WAYS TO FIGHT A DEADLY DISEASE

Bridget Eklund, a microbiology major from Scandia, Minnesota, uses cockroaches to study a **bacterium** that can cause a deadly disease. As an undergraduate lab assistant in the microbiology and immunology lab of Nathan Fisher, Ph.D., she received a prestigious Goldwater Scholarship and an **Astronaut** Scholarship. As a double major in biotechnology and microbiology, part of her research involves studying how specific bacteria can affect those with **cystic fibrosis**. Eklund is developing an improved **insect host system** for *Francisella tularensis*. In initial non-peer-reviewed study results, Eklund notes that the new host system could help in the discovery of ways to control the virulence of the bacterium and other factors that could assist in early stage drug discovery and development.

THE ORIGAMI OF THIN FILMS

Andrew Croll, Ph.D., assistant professor in the Department of Physics, and his research team are examining how randomly crumpled and purposefully folded **polymeric materials** eventually could be used as lightweight structural components in aerospace applications. The secrets of these bends and folds could provide information that leads to lightweight and strong components to make aircraft and spacecraft more efficient. Croll received a Young Investigator Award from the U.S. Air Force Office of Scientific Research in support of the thin film research.



ECONOMIC AND SOCIAL IMPACTS OF OIL DEVELOPMENT CONTINUE

The cyclical nature of energy development results in many transitions, including in the oilfields of North Dakota's Bakken region. Researchers at NDSU have continued to contribute to studies of oil development in the state, covering topics that include population projections, law enforcement needs, water quality and soil conservation — all which provide community leaders with planning tools during various economic boom and downturn cycles. Included among the many research topics under study: Resident Attitudes Toward Oil Fracking in Rural North Dakota — The Role of Community Values in Attitude Formation conducted by Felix Fernando, graduate student in Natural Resources Management, and Dennis Cooley, Ph.D., professor of philosophy, in the Department of History, Philosophy and Religious Studies. It is one of five studies that also cover housing, quality of life and rural development. Prior research by Nancy Hodur, Ph.D., research assistant professor, and Dean Bangsund, Ph.D., research scientist, both in the Department of Agribusiness and Applied Economics, covers ongoing [economic impacts](#) of energy development.

AVOIDING MUSCLE LOSS AS WE AGE

No need to look like Hercules, although maintaining muscle mass as we age could mean fewer disabilities later in life. NDSU students are studying how that might be possible. Students who participate in the Muscle, Metabolism, and Ergogenics Laboratory, are interested in research about muscles — from the elite athlete to the average aging adult. Some in the group are involved in a research study that explores the relationship between consuming protein and how it affects skeletal muscle health across the aging process. Kyle Hackney, Ph.D., assistant professor in the Department of Health, Nutrition and Exercise Sciences, leads the research. He received a [Sanford Health](#) seed grant to explore the aging and muscle mass connection. “Our goal is to identify optimal intervention strategies using diet and/or exercise to mitigate these negative outcomes and improve/maintain muscle mass, strength and mobility as we age,” said Hackney.



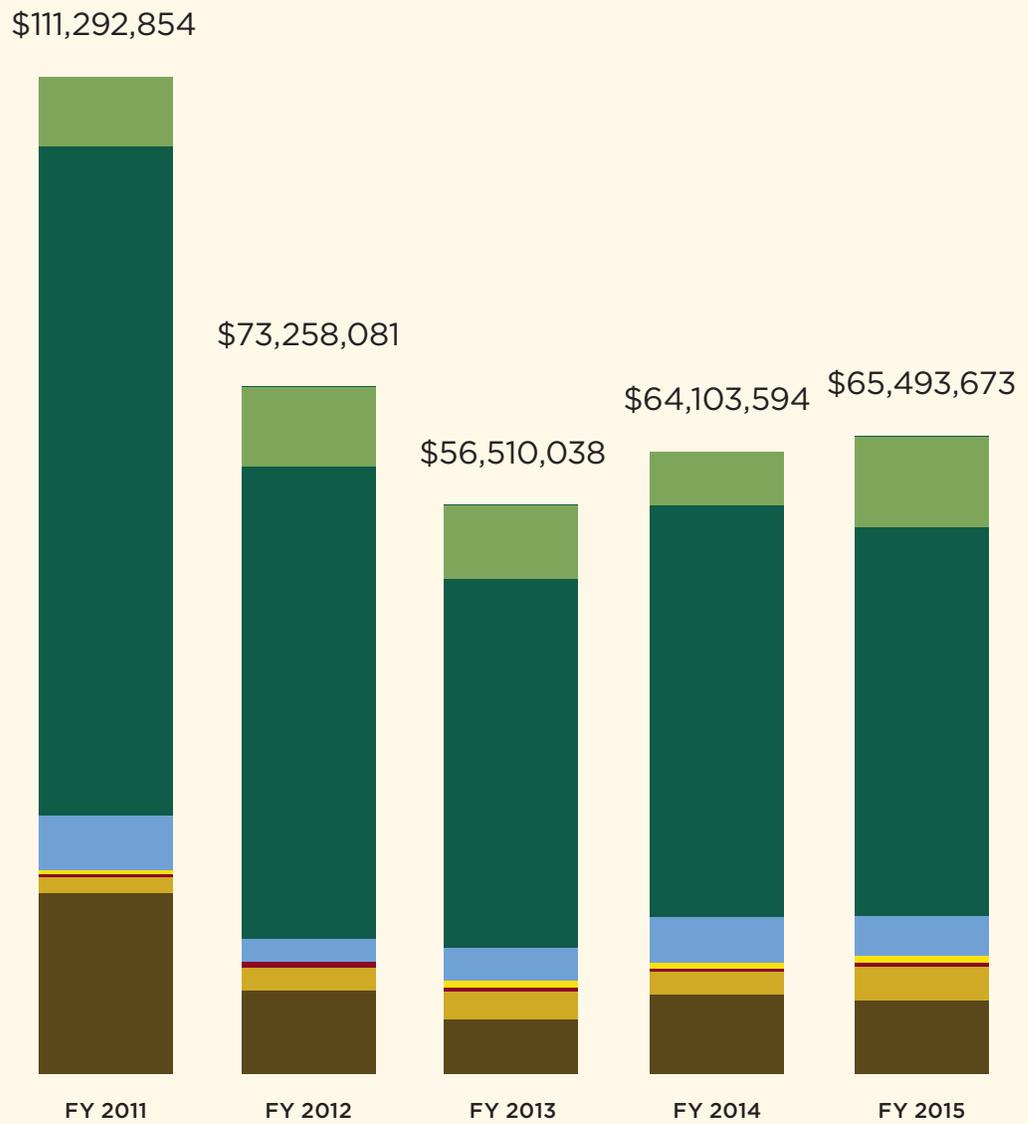
UAV OPPORTUNITIES SOAR IN NORTH DAKOTA

The New York Times calls North Dakota “[A Silicon Valley for Drones.](#)” UAV opportunities in the state are soaring as teams at NDSU focus on unmanned aerial vehicle research, particularly in precision agriculture. NDSU projects include data collection for crop management with infrared, thermal, color and multi-spectral imagery. NDSU’s Center for [Computationally Assisted Science](#) and Technology assists in analyzing collected data.



[NDSU’s UAV team](#) includes representatives from its colleges, providing multidisciplinary expertise in [UAV research](#). North Dakota’s one-team approach provides an unparalleled unmanned aerial systems research environment through partners in the Northern Plains Unmanned Aircraft Systems [Test Site](#). The FAA gave approval to the Test Site for drones to fly up to 1,200 feet above the entire state, including night flights, allowing UAV opportunities to continue to expand in the state.

EXTERNAL AWARDS BY SOURCE



Source	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Commodity	\$5,692,514	\$7,714,908	\$7,590,644	\$6,213,329	\$8,028,993
Federal	\$82,271,268	\$53,329,098	\$37,578,382	\$43,545,478	\$43,828,337
Foundation/Non-Profit	\$4,116,481	\$1,970,710	\$3,184,943	\$4,115,664	\$3,943,861
Other	\$259,769	\$64,770	\$390,571	\$358,114	\$408,479
Other Government Office	\$134,493	\$473,201	\$231,850	\$353,463	\$332,013
Private	\$1,462,904	\$1,832,066	\$2,307,909	\$1,880,835	\$2,856,041
State	\$17,355,425	\$7,873,328	\$5,225,739	\$7,636,711	\$6,095,949

*An adjustment was made to the previously published FY 2011, 2012 and 2014 External Awards total. The adjusted award total is included here.



A CUP OF JOE. MADE OF JAVA.

North Dakota startup company [c2renew](#) arose from NDSU research focused on turning agricultural byproducts into biocomposites for injection molding. In one of the company's latest ventures, they've prototyped a coffee mug made out of [coffee byproducts](#). Co-founded by Chad Ulven, Ph.D., associate professor of mechanical engineering, and NDSU graduate Corey Kratcha, c2renew also works on consumer products for printer cartridges, parts used in construction equipment for global corporations and consumer products for insect control.



The company also partners with 3Dom USA, a company that creates 3-D printing filament made from coffee leftovers and makes filament from byproducts that result from the beer-making process. According to company officials, the majority of c2renew's team is comprised of current students or NDSU graduates, giving students start-up business experience and providing recent graduates opportunities in a technology-based company. Its location in NDSU's Research and Technology Park provides convenient access to working with the university and recruiting future employees.

STUDY RESULTS SHOW POTENTIAL IMPACT OF F-M DIVERSION ON FARMERS

The Fargo-Moorhead Diversion Authority contracted with the NDSU Department of Agribusiness and Applied Economics to study how [farming revenues](#) could be affected by operation of the diversion to help control flooding in the region. Dean Bangsund, Ph.D., NDSU research scientist, led the research that included computer modeling with 39.2 million data points to gauge resulting impacts of water storage areas and other aspects associated with the diversion. Part of the research simulates how long planting would be delayed at 5, 10 and 500-year flood stages.



STUDENT RESEARCH LEADS TO MAJOR INSECT DISCOVERY

Ever since childhood, Mariom Carvajal wanted to be a biologist. As a student researcher, she led a team of NDSU entomology researchers who identified and described two new species of jewel shield bugs – *Tolono pallidus* and *Tolono confusus*. Her research paper was published in Proceedings of the Entomological Society of Washington, a prestigious scientific journal. “It’s like a shot of adrenaline, like a roller coaster ride. It’s really, really exciting,” Carvajal said of her moment of discovery. The junior student who grew up near Santiago, Chile, is majoring in microbiology. She received a first place award and an honorable mention for her previous presentations at [NDSU EXPLORE](#), which recognizes achievements in undergraduate research and creative activity. She already is listed as an author or co-author on 22 published papers, has analyzed insect collections at the Smithsonian Institution, and received a presentation award from the International Heteropterists’ Society.

USING RESEARCH TO BATTLE THE MOST PREVALENT CANCER

Lung cancer kills more people than any other type of cancer, according to the [Centers for Disease Control](#). Katie Reindl, Ph.D., assistant professor of biological sciences, is examining a novel approach to attacking lung cancer before it starts. [Flaxseeds](#) may be small in size, but studies suggest they pack a punch in health benefits and Reindl wants to determine something very specific.

“The potential impact for this research will be identification of a novel approach to help protect current or former smokers from developing lung cancer,” said Reindl. Through a seed grant from [Sanford Health](#), Reindl is focusing her research on smokers in the American Indian community. While stopping smoking is the best approach for preventing lung cancer development, many individuals are unable to quit, and those who do still face a higher risk of developing lung cancer. Reindl notes that flaxseed holds tremendous promise as a chemopreventive agent, given its high lignan content which has anti-oxidant effects, and omega-3 fatty acid content, which has anti-inflammatory effects. According to Reindl, this is the first study to look at the chemopreventive effects of dietary flaxseed in a population at high-risk for lung tumor development.



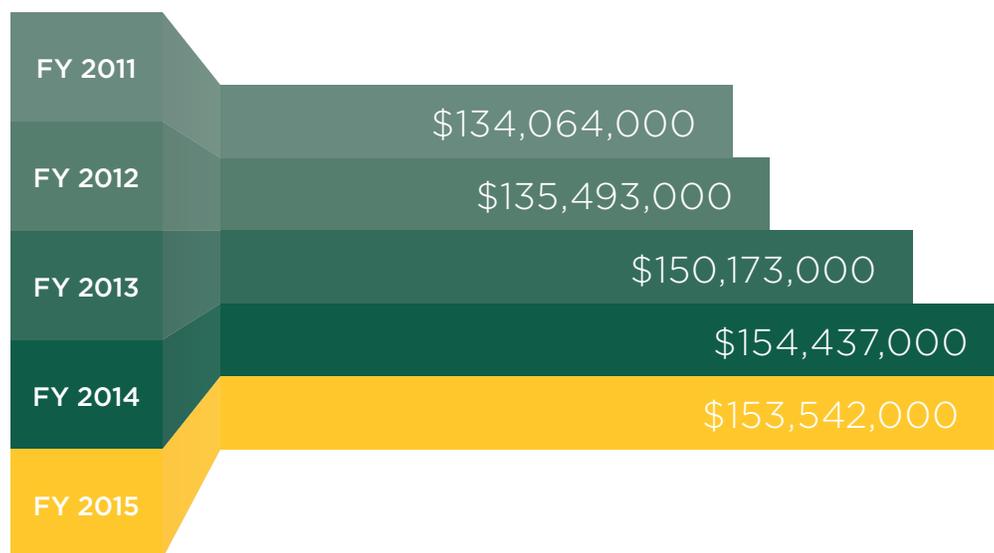
TOBACCO GOES TO COLLEGE

In her book “[Tobacco Goes to College: Cigarette Advertising in Student Media, 1920-1980](#),” Elizabeth Crisp Crawford, Ph.D., associate professor in the Department of Communication, studied how tobacco advertising targeted college students to smoke, smoke, smoke that cigarette. The book’s in-depth analysis of vintage cigarette ads provides insights into sophisticated advertising that was well ahead of its time, with the evaluation of it still applicable in the way today’s e-cigarettes are promoted.

CAREER AWARDS HIGHLIGHT TOP YOUNG FACULTY CONTRIBUTIONS

Peter Bergholz, Ph.D., assistant professor in Veterinary and Microbiological Sciences, and Wei Jin, Ph.D., assistant professor in Computer Science at NDSU, each received five-year Faculty Early Career Development (**CAREER**) awards from the National Science Foundation. Bergholz studies **bacteria we can't see**, but that can make us sick. The research has implications for how new biological capabilities arise in nature, including the emergence of new infectious diseases. Jin's research focuses on developing smarter, more efficient **computer science** methods to search for connections across documents in a large-scale setting. The final research generated could impact areas such as biomedical and healthcare applications, homeland security and aviation safety.

NDSU HIGHER EDUCATION R&D EXPENDITURES



FY11-FY14 data available from NSF at <http://www.nsf.gov/statistics/srvyherd/#tabs-2>.
FY15 data based on information provided to, but not yet published, by NSF.



ENERGIZING ENTREPRENEURS AND ENGAGING STUDENT RESEARCHERS

Innovation Challenge and NDSU EXPLORE for undergraduates are just two of the annual opportunities for students to present their innovative ideas and share their research and scholarly successes. The NDSU Research and Technology Park and Office of the Provost spearhead [Innovation Challenge](#). Students receive an opportunity to present their ideas to business leaders and compete for prizes to further develop their innovations. A drone system with improved flight characteristics, a website that helps people stay connected to their communities, and a mechanical way to reduce weed pressure won their categories in NDSU's annual student innovation competition in 2015. At [NDSU EXPLORE](#), from research on bones to research on Superbowl commercials, nearly 100 undergraduates shared their research and scholarly activity. First place winners in each category who meet criteria receive the opportunity for a travel award to present their research or creative activity at the National Conference on Undergraduate Research in 2016.

COULD YOU SLEEP YOUR WAY TO A SLIMMER WEIGHT?

While it's not quite that simple, a new study at NDSU, funded with a seed grant from [Sanford Health](#), may provide results that help determine how sleep, diet, weight loss and exercise are related, leading to better ways to manage weight. The study is among three selected for a total of \$250,000 in funding from Sanford Health. "Obesity is a growing epidemic in our modern society, yet the majority of all weight loss efforts, which typically involve changes to diet and exercise habits, ultimately fail," said Leah Irish, Ph.D., assistant professor of psychology at NDSU. Irish and her group of student researchers are monitoring sleep, diet and exercise among people trying to lose weight. If poor sleep is found to undermine positive changes to diet and exercise, then it may be important to consider adding sleep promotion into weight management programs along with diet and exercise.



CREATIVE ACTIVITIES ENRICH STUDENT OPPORTUNITIES

The [NDSU Chamber Music Festival](#) announced its inaugural season in 2015. The only festival of its kind in the nation partners NDSU student pianists with professional string players from across the country in performances of great chamber music works of classical composers. The NDSU Challey School of Music, the American Choral Directors Association and the American Composers Forum held the [NDSU Choral Symposium: Contemporary Composition in America](#). Headlined by world-renowned composer and conductor Eric Whitacre, the symposium also included several nationally and internationally known composers, all of whom worked with NDSU choir students in sessions and in concert. Students and faculty also participated in an innovative pair of concerts with headliner composer James Stephenson, performing his Devil's Tale along with Stravinsky's classic Soldier's Tale.

In the area of performing arts, students received opportunities in theater productions such as *Next to Normal*, *Lysistrata*, *Bloody Bloody Andrew Jackson* and *Cat on a Hot Tin Roof*. In additional activities, the NDSU Department of Visual Arts and Fargo Theatre partnered to present the Art Cinema Series, showcasing fine films. NDSU Visual Arts students exhibit their artwork at two galleries on campus: Renaissance Hall Gallery and the Memorial Union Gallery.



BIG DATA, BIG CALCULATIONS, BIG RESULTS

When it comes to research, scientists generate mountain ranges of data. Standard computer systems cannot handle what is known as “big data” — high velocity, high volume data sets used in simulations and in other areas of computational research. The Center for Computationally Assisted Science and Technology, known as **CCAST** at NDSU, provides high-performance computing infrastructure, including a resource called “Big Thunder,” a high performance computer cluster to assist faculty and students with their research exploration. In addition to supporting NDSU researchers, CCAST pursues scientific discovery in the areas of energy, materials, environment, security, health and other areas of national priority.



CCAST provides researchers access to additional state-of-the-art computing resources, where “big data” analytics are efficiently coupled to high-performance modeling and simulation environments.

In today’s competitive research funding environment, researchers and educators often use high-performance computers with significant power to conduct experiments and create models that may use millions of data points.

Yildrim Bora Suzen, Ph.D., associate professor of mechanical engineering, for example, uses CCAST’s infrastructure for simulations of biofluids, among other computational thrusts within his research group. One biomedical application the group is pursuing involves predicting the blood flow in cerebral aneurysms. The complex research focuses on factors used to predict if and where an aneurysm will rupture or where it has ruptured previously.



Svetlana Kilina's research group is on the frontier of modern computational chemistry and nanoscale science. Kilina, Ph.D., assistant professor of chemistry, works to provide novel material design strategies with new technological applications. The research targets society's need for efficiently operating optoelectronic devices, solar cells, chemical sensors, bioimaging and other applications.



In other research areas, Kalpana Katti, Ph.D., University Distinguished Professor of civil engineering, and Dinesh Katti, Ph.D., Jordan A. Engberg Presidential Professor and interim chair of civil engineering, use CCAST computers for multiscale modeling of nanoscale systems. Their research has induced a paradigm shift within the mechanics community, changing how the fundamental mechanisms that control nanoscale systems are viewed. Researchers in various fields are now adopting their approach and techniques. Their additional research in bone tissue engineering and the biology of stem cells provide the potential for great impact in the area of regenerative medicine as well.

Many more researchers use CCAST to expand their explorations. The total aggregated theoretical peak performance of **Big Thunder** approaches 40 teraflops. As researchers' computational needs at NDSU grow, what's called a condominium model allows researchers and research groups to add their own compute and storage hardware modules and/or storage media to Big Thunder for economies of scale.

Funding for Big Thunder at NDSU was provided by the NDSU Office of the Provost, the U.S. Department of Energy and the National Science Foundation.

NORTH DAKOTA EPSCoR STRIVES TO INCREASE STATE'S RESEARCH COMPETITIVENESS

North Dakota colleges and universities collectively seek research opportunities by participating in the North Dakota Experimental Program to Stimulate Competitive Research. ND EPSCoR's goal is to increase the research competitiveness of the state's colleges and universities. Funded by the National Science Foundation and by support from the North Dakota Legislature, [ND EPSCoR](#) also supports education, diversity and workforce development.



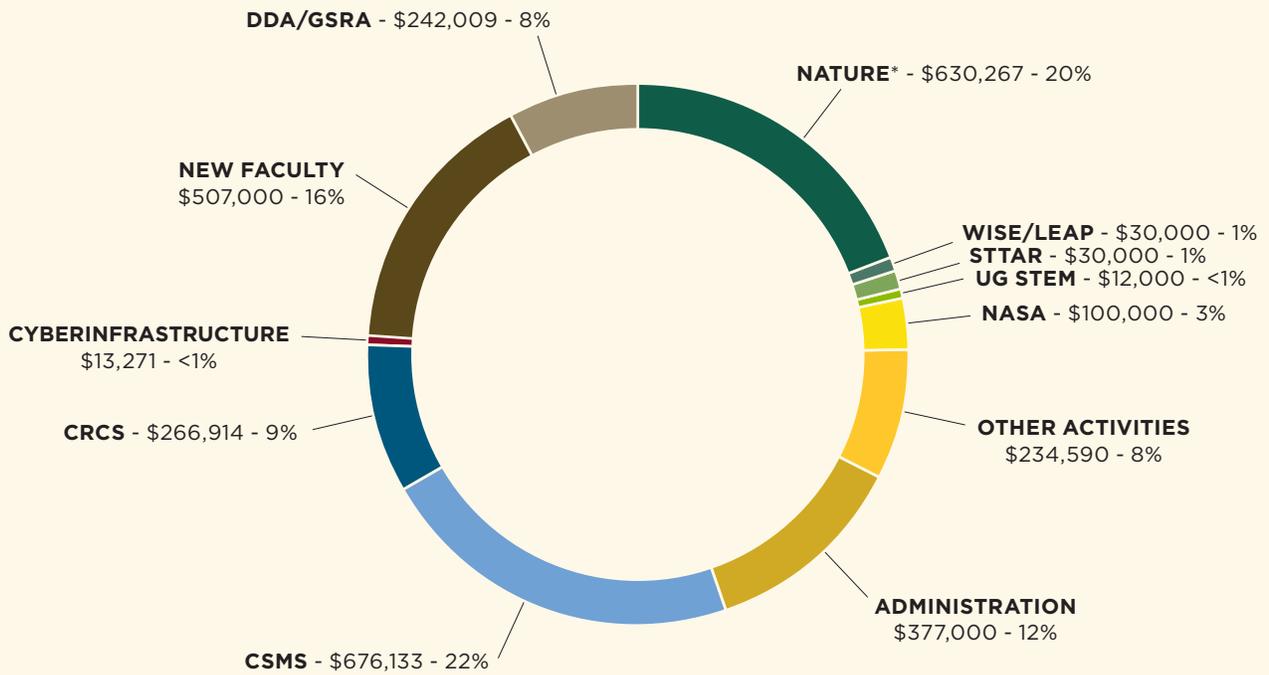
In 2014, the National Science Foundation awarded a competitive five-year research infrastructure improvement grant award totaling \$20 million to ND EPSCoR. The award, called INSPIRE-ND (**IN**novative and **Strategic Program Initiative for Research and Education - North Dakota**), strengthens North Dakota's research competitiveness; provides research and STEM education opportunities for students across the state, including Tribal Colleges and primarily undergraduate institutions; enhances additional research collaboration between universities and colleges; uses agricultural raw materials to develop sustainable materials; and engages regional climate studies to help predict hydrology and impact on agriculture.

Additionally, this program contributes to North Dakota's traditional economic driver of agriculture, while developing science infrastructure for new high technology and market sectors. Its goals include efforts to build and diversify the state's science and technology workforce for advanced manufacturing, energy and technology-based business.

ND EPSCoR programs also provide research opportunities for high school and undergraduate students, promote STEM activities for K12 students, offer research and teaching assistantships for graduate students, include academic support for underrepresented groups, and provide a program for summer science and technology-based undergraduate student internships in private companies.

Tribal colleges located in North Dakota, primarily undergraduate institutions in the state, and the state's largest research universities are collaborating to make these critical STEM initiatives successful. Two statewide research areas supported by ND EPSCoR — the Center for Sustainable Materials Science and the Center for Regional Climate Studies — focus on biomaterials and climate change respectively, two factors that impact agriculture and the extractive energy industry in the state. Both areas of research include faculty collaborators from primarily undergraduate institutions, tribal colleges, NDSU and UND.

FY15 ND EPSCoR FUNDED PROJECTS - NDSU CAMPUS



DDA - Doctoral Dissertation Assistantship
GSRA - Graduate Student Research Assistantship
CSMS - Center for Sustainable Materials Science
UG STEM - Undergraduate STEM program
NATURE - Nurturing American Tribal Undergraduate Research and Education

WISE - Women in Science and Engineering
STTAR - Students in Technology Transfer And Research
CRCRCS - Center for Regional Climate Studies

*Includes all funds spent directly at the five Tribal Colleges; a joint program of both the NDSU and UND campuses, the funding passes only through the NDSU campus.



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