



NDSU OFFICE OF RESEARCH AND CREATIVE ACTIVITY

FISCAL YEAR 2014 // ANNUAL REPORT

WEAVING A STRONG, INTERCONNECTED WEB

At NDSU, an interconnected and collaborative approach to research and creative activity enhances our mission as a land grant institution to serve the state, to enhance student learning and to generate knowledge and discovery through basic research and scholarly activities.

As part of the higher education system, research universities also are among the resources available to enhance sustained economic growth in the region. This ecosystem is part of an interconnected web that fuels success. Research universities are in a position to prep the pipeline with human capital—students and graduates who can assist communities and businesses in meeting future challenges.

One way to accomplish that mission is by strengthening the state's research infrastructure. The North Dakota Experimental Program to Stimulate Competitive Research, a North Dakota University System program, received a \$20 million competitive federal award over five years to further this mission. The award includes Innovation and Strategic Program Initiatives for Research and Education (INSPIRE-ND) to contribute to North Dakota's traditional economic drivers, while developing science infrastructure for high technology and market sectors.

Such research initiatives help build on current success. In the Higher Education Research and Development Survey by the National Science Foundation, NDSU reports research expenditures of more than \$150 million. NDSU remains the only North Dakota university listed among the top 108 U.S. public and private universities in the Carnegie Commission on Higher Education's category of "Research Universities/Very High Research Activity."

The extensive research activity also appears statistically through our Technology Transfer Office that manages more than 300 technologies generated at NDSU, with an average of more than 33 potentially patentable inventions each year since 2004. For the third consecutive year, intellectual property licenses managed through the NDSU Research Foundation generated more than \$2 million from NDSU technologies and discoveries.

The web of discovery and knowledge creation also expands through opportunities to encourage entrepreneurship. The NDSU Research and Technology Park coordinates Innovation Challenge, providing students opportunities to generate and potentially commercialize good ideas for market. More opportunities are provided through NDSU EXPLORE, an annual event that allows undergraduate students an opportunity to present their research to the community.

We've developed new senior design template agreements that provide ways for undergraduate students to potentially possess intellectual property and discoveries generated from their senior design projects created within for-credit courses. These template agreements permit students who choose to work with companies on projects to select how they ultimately prefer to share and protect their discoveries.

Research growth includes added responsibility for research integrity and compliance. An export controls officer at NDSU assists university faculty, staff and students in navigating complex federal laws governing access to research equipment and information. Regulations affect areas as varied as purchasing to faculty travel, as well as information and technology that is restricted to countries specified by the federal government.

Effectively managing current programs maintains initial success, but further strengthening of research opportunities requires additional partnerships that benefit students, industry and businesses. A newly added executive director for corporate and foundation research relations on our business/industry team enhances opportunities with partners interested in accessing research expertise here. With more than 30 private sector partners, we look to expand opportunities.

As a land-grant institution, research opportunities stem from wide-ranging and long-lasting commitments to the state. The North Dakota Agricultural Experiment Station carries out programs that contribute to research achievements with significant impact to the economy of the state and region. In addition, congratulations to the NDSU Extension Service for its contributions to North Dakota, providing services and education that have extended knowledge and changed lives for the past 100 years.

As the future unfolds, we are building a strong web of partners and an interconnected pipeline of human assets. NDSU faculty play a pivotal role in creating that pipeline. They continue to receive accolades for achievements in teaching, research and creative activity. Preparing students and prepping the pipeline with human capital helps the region achieve sustained economic success, strengthens communities, enriches lives, and provides future opportunities for students.

Thank you for your interest in our creative activity and research enterprise.



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



It takes more than a single snapshot to capture a panoramic picture. Extensive research conducted at North Dakota State University spans many different areas. This report provides a snapshot of achievements by students, faculty and staff.

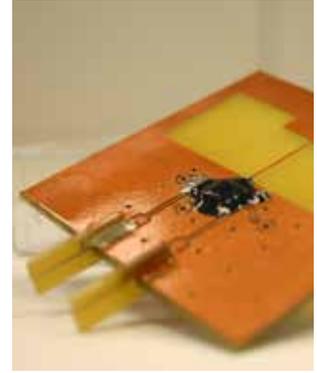
For an expanded view of NDSU research, scan the QR codes within this report or visit www.ndsu.edu/research.



THIS PLACE IS A ZOO

The NDSU Department of Biological Sciences and the Red River Zoo are partnering on an animal research facility for birds, bats and other small mammals. The facility is located on the zoo grounds in Fargo. “We have a similar commitment to conservation and ecology of regional species, which makes for a great partnership,” says Wendy Reed, associate professor and head of biological sciences. The building provides NDSU researchers with an ideal place for large-scale research projects on bats and birds. An exhibit area is planned to showcase the kinds of animals used in research. The project is funded by a \$60,000 National Science Foundation Advance FORWARD Institutional Transformation grant and \$30,000 in private donations.





SEEDING FUTURE OPPORTUNITIES

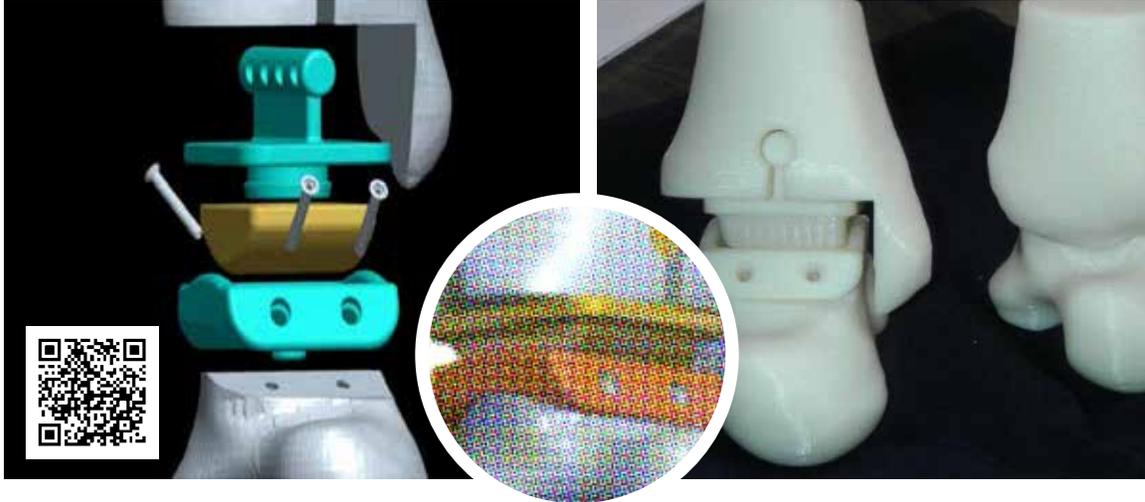
Precise in-the-ground measurement and monitoring of soil and crop conditions could provide opportunities for greater yields. NDSU researchers use microsensors in fields at the Soil Health and Agriculture Research Extension (SHARE) farm in central Richland county. Called SEED, which stands for Sensing Earth Environment Directly, researchers will plant the bio-degradable sensors in the ground like seeds, then directly measure soil salinity, moisture and chemicals in real time. Sensors use patent-pending technology developed at the Center for Nanoscale Science and Engineering, with researchers from Mechanical Engineering and NDSU Extension Service. The SEED technology is licensed to c2sensor, a North Dakota startup company that arose from NDSU research.

SERVING IN THE NATIONAL INTEREST

Kendall Nygard, professor of computer science, served as a Jefferson Science Fellow in 2013-14. Fellows serve as national science advisers on important foreign policy issues. Appointees spend one year at the State Department or the U.S Agency for International Development in Washington, D.C. Nygard worked with both government entities. According to Nygard, Department of State issues center on the role of science, engineering and medicine in international policy. At the Agency for International Development, the focus is on beneficial operations and assistance within developing countries. Following their one-year appointments, fellows are available for an additional five years as consultants. Thirteen academic scientists, engineers and physicians from institutions of higher education across the country were selected for the important positions.

“PHONE HOME” NOT FIRST OPTION

Parental advice given to college-bound students that they should “Phone home” may not be followed by today’s busy students. Research by Carrie Anne Platt, assistant professor of communication and doctoral students Renee Bourdeaux, originally of Huff, North Dakota, and Nancy DiTunnariello, East Brunswick, New Jersey, found that the fundamental communication question today is “Do I call or do I text?” Research findings published in *Studies in Media and Communication* found students prefer to text, and most students say they are in daily contact with their parents while juggling classes, internships and part-time jobs. Researchers found students tended to call if something was of high emotional importance or if they needed support.



FIXING WHAT'S BROKEN

NDSU researchers and a local podiatrist and surgeon have collaborated to develop a total ankle replacement technology. The approach features an inverted design in which the concave portion of the joint is at the bottom, and the convex portion is at the top. This patent-pending inverted design and mode of assembly and implantation could offer benefits to patients and surgeons by increasing average 10-year failure rates to a potential longevity of approximately 20 years more than existing implants. The research team includes Chad Ulven and Fardad Azarmi, associate professors of mechanical engineering, and Dr. Jared Aelony, podiatrist at Essentia Health.



BUILDING A BETTER BEAN

Two NDSU scientists are part of a national research team that successfully completed the common bean genome. North Dakota is the leading producer of dry edible beans in the U.S. Phil McClean, plant genomicist, and Juan Osorno, dry edible bean breeder in Plant Sciences, worked with other U.S. researchers to complete the genome. The team, which included postdoctoral scientist Sujana Mamidi, Machilipatnam, India; graduate student Samira Mafi Moghaddam, Tehran, Iran; and research associate Rian Lee, Argusville, North Dakota; sequenced and assembled a 473-million basepair genome of the common bean. The sequence revealed that disease resistance genes are highly clustered in the genome. This knowledge will lead to better breeding strategies to combat the many diseases that challenge bean crops. In addition, North Dakota was selected as the site of the National Agricultural Genotyping Center. This major federal laboratory facility will be located on the NDSU campus.



BIRDS OF A FEATHER

Franklin's Gulls are small, black-headed gulls of the interior North American prairies who breed in the summer, then migrate to the coast of South America. Undergraduate researcher Nicole Snyder of Dell Rapids, South Dakota, analyzed immune system function of the birds, looking for difference in Franklin's Gulls hatched during early and late season. The study examines cell damage to see if late-season chicks are giving something up to be ready in time to migrate. As a senior majoring in biochemistry and molecular biology, Snyder's preliminary results found that late-season chicks did have more damage to their DNA than early-season chicks. Snyder, who is part of a research group directed by Wendy Reed, associate professor and head of biological sciences, says there are benefits to undergraduate research. "It's no longer 'Oh, I've got to go to work now' but rather, 'I wonder what new or interesting thing will happen today?'" Snyder also received a prestigious Astronaut Scholarship awarded to outstanding undergraduate student STEM majors.

MORE THAN PRETTY PICTURES

A big part of science is computed through visuals - whether computer models, maps, diagrams, illustrations or other methods. Graduate student Jessie Arneson, a Jamestown, North Dakota native, received a prestigious National Science Foundation Graduate Research Fellowship to develop a method to improve science education. She determined that textbooks for undergraduates didn't help them achieve the scaffolding of skills they need when studying science. The three-year award of \$135,000 will help Arneson develop training methods to boost students' cognitive skills in science, technology, engineering and math education. In this national competition for funding, NSF funded 2,000 fellowships out of more than 14,000 applicants.



OPENING DOORS TO STEM

Spending two summers doing research at NDSU resulted in big changes for Ebony Sampson, now an NDSU graduate research assistant in cereal science. Outstanding students from across the country participate each summer in the NDSU Science, Technology, Engineering and Math program organized by the Office of Multicultural Programs in the Division of Equity, Diversity and Global Outreach. The program gives underrepresented ethnic minority students majoring in STEM fields the opportunity to engage in research. Sampson participated in the program as an undergraduate from Morgan State University, Baltimore, Maryland. After experiencing NDSU, she moved her husband and three children to Fargo to continue her education. "The summer STEM research program has opened the door to infinite possibilities for me," says Sampson.

STARTUPS BREED SUCCESS

Turns out, sugar coating works. Agricultural crops such as sugarbeets, sunflowers, flax and soybeans could play a major role in a bio-based green coatings technology developed by NDSU researchers to lessen dependence on petrochemicals. Based on sucrose and vegetable oils, the resins can be varied to perform in many applications and industries. [Renuvix](#), a start-up company stemming from research by Dean Webster, professor and chair in Coatings and Polymeric Materials, and Bret Chisholm in the Center for Nanoscale Science and Engineering, is located in NDSU's Research and Technology Incubator. The U.S. Department of Agriculture and the United Soybean Board provided initial research funding. Renuvix expects commercial scale production of sucrose ester resins to begin in 2015.

Previous NDSU-related startup and Technology Incubator graduate [Myriad Mobile](#) continues to build on initial successes. Jake Joraanstad and Ryan Raguse launched the business while students at NDSU in 2011. The company's growth resulted in moving from the NDSU Incubator in 2012 to space near the Incubator. Additional growth resulted in a move to downtown Fargo in 2014. The company, which designs, develops and consults on mobile applications for business, has grown to more than 60 employees in seven markets. Entrepreneur magazine selected Myriad Mobile in its top 30 startups to watch.

North Dakota startup company [c2renew](#) corporation arose from NDSU research focused on turning agricultural byproducts into biocomposites for injection molding. Co-founded by Chad Ulven, associate professor of mechanical engineering, the company now works on applications as varied as consumer products for insect control, printer cartridges and parts used in construction equipment for global corporations. Ulven and his business partner, Corey Kratcha, recently licensed additional NDSU-developed technologies from the NDSU Research Foundation and formed a second company, c2sensor corporation.

A chromium-free paint developed through research at NDSU and licensed to startup [Elinor](#) Specialty Coatings, Inc., is a 2014 TechConnect National Innovation Awardee. Elinor licensed the technology through the NDSU Research Foundation, and developed Aluma45 MgRP™, a chromium-free magnesium-rich primer for use on aluminum-alloys and composites in ship, automotive and construction materials manufacturing. The TechConnect National Innovation Awards selects top early-stage innovations from around the world.

Startup [HQC Biosciences](#) uses patent-pending technology licensed from the NDSU Research Foundation to utilize lipid nanoparticles that quickly and easily detect contaminants and other targets in biological samples. President Erin Nyren-Erickson, an NDSU graduate, also operates Discovery Express, teaching science and math to kids to encourage pathways to STEM fields.

In fiscal year 2014, the NDSU Research Foundation executed 41 license agreements stemming from NDSU technologies and innovations. Eight patents were newly issued to protect NDSU discoveries.

BY THE NUMBERS

41 license agreements
FY14

30+
business partners

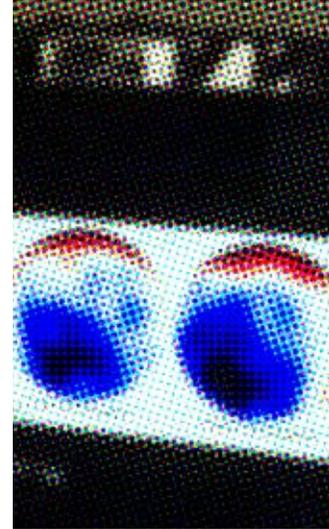
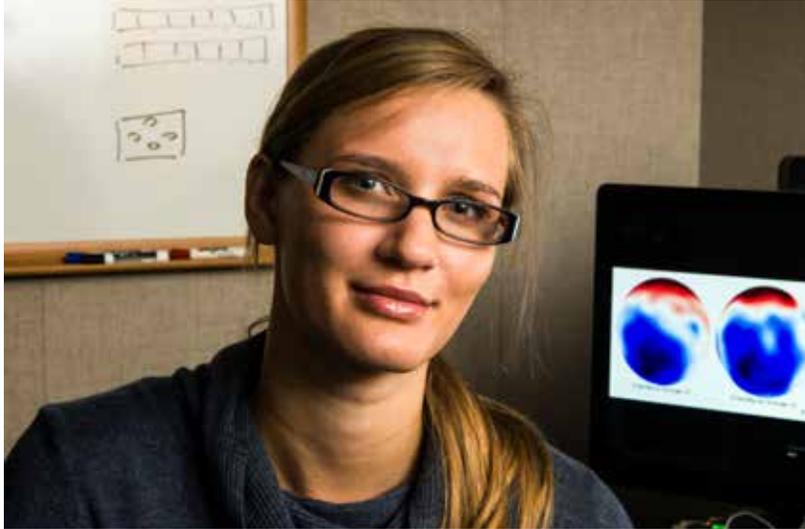
6 business startups
since 2010

300+
technologies

71 patents and
60 pending
total active in FY14

\$2M+
licensing revenues
FY14

Contact ndsu.businessdev@ndsu.edu to learn more about engaging in research partnerships.



BRAIN AND LANGUAGE CLUES

The English language contains words that can be used interchangeably as nouns and verbs. Katie Dockter of Fargo used her undergraduate research experience in psychology at NDSU to study whether adults have the same neural and behavioral activity that is found when a child hears or processes language. NDSU researchers are discovering the brain is sensitive to acoustic differences between noun and verb uses of the same word. Dockter was part of the research team in assistant professor Erin Conwell's lab. "Research gives you hands-on based learning that you can't get from sitting in a classroom," says Dockter.



TOOT YOUR HORN

NDSU graduate student Clayton Miranda of Juiz de Fora, Brazil, knows the power of music. Miranda, who is pursuing his doctoral degree in trumpet performance, published groundbreaking research on trumpet music history in the International Trumpet Guild Journal. He conducted 14 years of research on the history of the trumpet in Brazilian music, covering 6,000 manuscripts dating back more than 400 years. Jeremy Brekke, associate professor of music and Miranda's adviser, notes "His research will enrich the whole trumpet community through great works with a different cultural background."



\$20 MILLION AWARD SUPPORTS STATEWIDE RESEARCH

The National Science Foundation awarded a competitive research infrastructure improvement grant award totaling \$20 million to the North Dakota Experimental Program to Stimulate Competitive Research ([ND EPSCoR](#)). The award funds research centers and integrated education programs in sustainable materials science and regional climate studies.

The five-year award is slated to:

- Build research infrastructure and strengthen North Dakota's research competitiveness,
- Provide research and STEM education opportunities for students across the state, including Tribal Colleges,
- Enhance additional research collaboration between universities and colleges,
- Use agricultural raw materials to develop sustainable materials,
- Engage regional climate studies to help predict hydrology and impact on agriculture, and
- Enhance scientific computing and other infrastructure.

Additional programs funded by the award are included in INSPIRE-ND, Innovation and Strategic Program Initiatives for Research and Education. 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 in the state.

WHERE RUBBER MEETS THE ROAD

NDSU researcher Magdy Abdelrahman, associate professor of civil and environmental engineering, is working on a technology that could reduce road maintenance costs, as well as tire waste in landfills. He is researching methods that could bring more rubberized asphalt to potential markets. Abdelrahman develops additives that can be used with rubberized asphalt compounds. He is investigating whether the additives used to control interaction between asphalt and tire rubber will release harmful chemicals when the asphalt is exposed to harsh weather conditions. His research looks for ways to improve the compounds, while ensuring that they are environmentally friendly. The rubberized asphalt has properties of interest to industry, since it lasts longer on roadways and aids in reducing traffic noise. Abdelrahman is a previous National Science Foundation CAREER Award recipient.

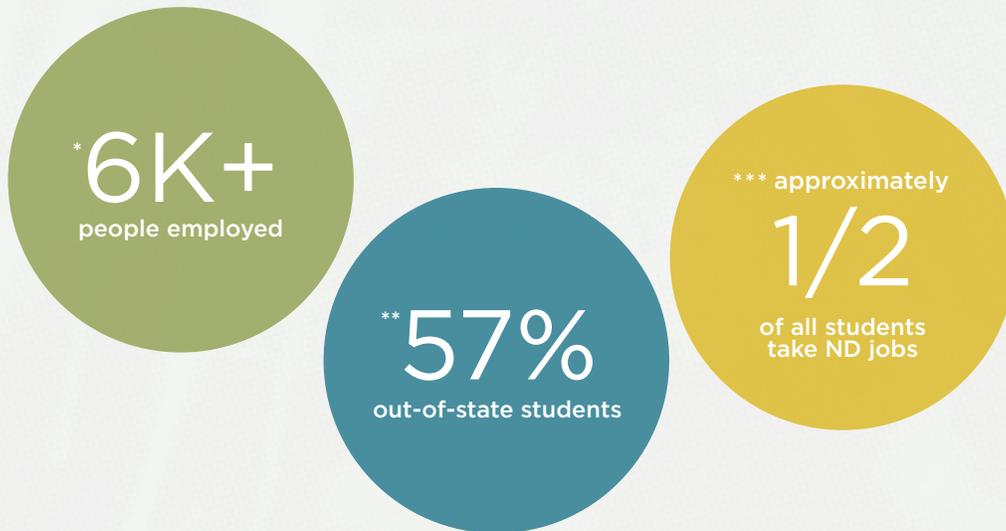
ENERGIZING ENTREPRENEURS

To create an entrepreneurial ecosystem, the NDSU Research and Technology Park annually spearheads Innovation Challenge, which gives students an opportunity to develop and present their ideas to business leaders and compete for prizes to continue refining their inventions. The University Economic Development Program at NDSU's Research and Technology Park also received a \$100,000 investment from the U.S. Economic Development and Research Administration. The investment funds the second year of a five-year program that provides resources and technical assistance to support entrepreneurs from the region to capitalize on economic development opportunities from applied research.

NAMED AMONG BEST

In naming Fargo as one of the Best Small Cities for Business and Careers, Forbes magazine noted NDSU's research reputation.

"North Dakota State University brings stability to the Fargo economy. It employs more than 4,000 people and has developed into a major research university. ... Roughly 60% of NDSU students are from out of state, but more than half take jobs in North Dakota after graduation."



Source:

www.forbes.com/sites/kurtbadenhausen/2014/08/07/fargo-heads-list-of-best-small-cities-for-business-and-careers/

*Office of Institutional Research and Analysis, Fall 2014, full-time, temp and student workers. Data from Human Resources/Payroll 9/30/2014 pay period end date.

**Office of Registration and Records, all undergrads, Fall 2014

***Undergrads surveyed who reported securing jobs in ND, NDSU Career Center 2013 Annual Employment Report

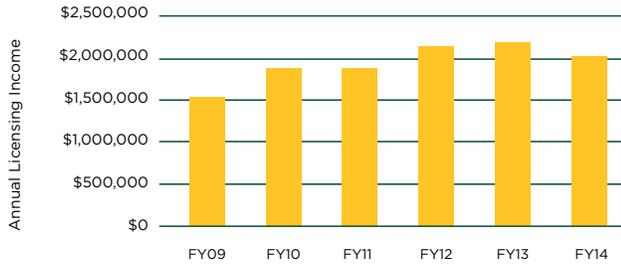


SOARING INTO THE FUTURE

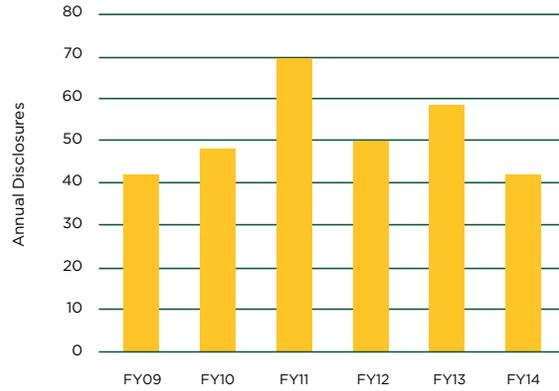
Miniaturized microelectronics developed at NDSU could aid in transforming the National Airspace System to accommodate unmanned aircraft systems. Researchers in Electrical and Computer Engineering and the Center for Nanoscale Science and Engineering are developing prototype radio frequency integrated circuits that merge functionality into a single microelectronics chip. The activity is funded through the North Dakota Center of Research Excellence program. Agriculture and Biosystems Engineering activities include UAS-mounted sensors to assess field crop and livestock production issues. Test flights have been conducted by the Northern Plains Unmanned Systems Authority and University of North Dakota Aerospace at NDSU's Carrington Research Extension Center.



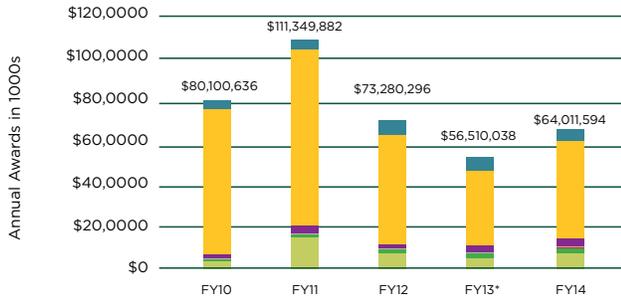
LICENSING INCOME



INVENTION DISCLOSURES

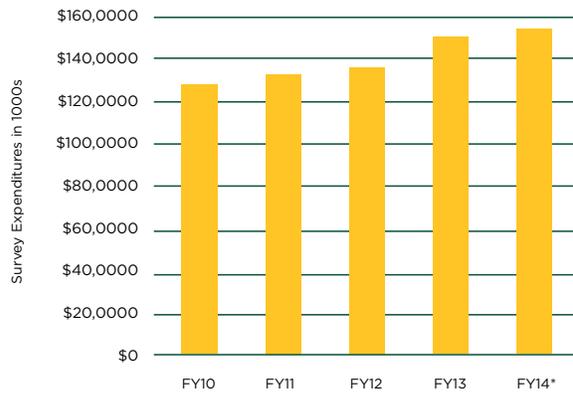


EXTERNAL AWARDS BY SOURCE



Source	FY10	FY11	FY12	FY13*	FY14
Commodity	\$4,507,847	\$5,692,514	\$7,732,125	\$7,590,644	\$6,215,409
Federal	\$68,732,665	\$84,972,845	\$53,898,413	\$37,378,387	\$43,799,035
Foundation/Non-Profit	\$1,986,513	\$3,804,059	\$1,904,028	\$3,384,938	\$3,923,261
Other	\$131,154	\$259,769	\$64,770	\$390,571	\$358,114
Other Government Office	\$199,546	\$134,493	\$412,536	\$231,850	\$353,463
Private	\$1,007,048	\$1,510,575	\$1,890,399	\$2,307,909	\$2,069,157
State	\$3,535,863	\$14,975,627	\$7,378,025	\$5,225,739	\$7,293,155

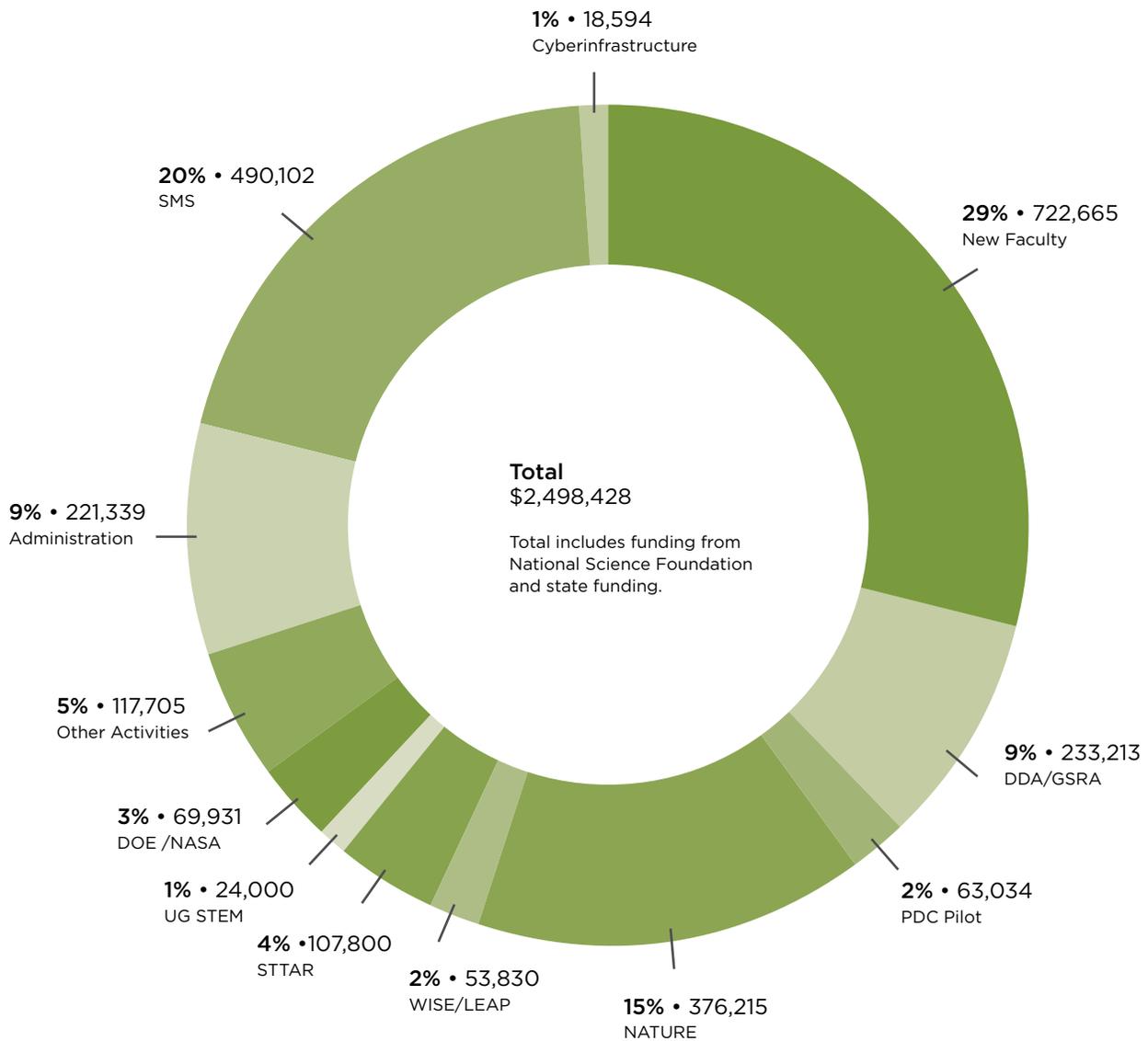
NDSU HIGHER EDUCATION R&D EXPENDITURES (HERD)



FY10 - FY13 figures are as reported to the National Science Foundation. www.nsf.gov/statistics/srvy/herd/#tabs-2
 *FY14 figure is projected, not final, to be reported in 2015.

*An adjustment was made to the previously published FY13 External Awards total. The adjusted number is included here.
 NEW EXTERNAL AWARDS TO NDSU GREW BY 13 PERCENT IN FY14.

FY14 NDSU EPSCOR FUNDED PROJECTS



Graph represents one-year disbursement of previous five-year award at NDSU from National Science Foundation. As of August 2014, the North Dakota Experimental Program to Stimulate Competitive Research received a new \$20M five-year competitive award from NSF for research activities across the state.

- DDA - Doctoral Dissertation Assistantship
- DOE - Department of Energy
- GSRA - Graduate Student Research Assistantship
- NATURE - Nurturing American Tribal Undergraduate Research and Education
- PDC Pilot - Product Design Center
- SMS - Sustainable Materials Science Research Cluster
- STTAR - Students in Technology Transfer And Research
- UG STEM - Undergraduate STEM program
- WISE - Women in Science and Engineering



www.ndsu.edu/research