The Research Enterprise Annual Report is published every year by the Office of the Vice President for Research. This report is a snapshot of the innovative and important work done by NAU faculty in FY2012.
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Beginning in 2008, The Arizona Board of Regents (ABOR) asked NAU to contribute to a growing research expectation for the three state universities in Arizona. This expectation includes the discovery of new knowledge, the translation of research outcomes to commercially useful intellectual property, and the application of research as a catalyst for state economic and social development. In 2010, ABOR formalized this expectation in the document, “Higher Education Enterprise Plan Strategic Realignment 2010 Forward.” Under this plan, NAU is expected to increase research expenditures by 50 percent, a significant jump in the best of times, and extremely challenging in the current economic climate. To achieve these goals, NAU is developing a new strategic research plan to promote current areas of research strengths, grow new strategic research directions, build productive research centers, support larger interdisciplinary opportunities, and actively seek out and participate in more inter-university collaborations. These new programs and initiatives will solidify NAU’s prominence as a national research university.

**A Vision for the NAU Research Enterprise**

While Northern Arizona University is a national leader in research areas that are of specific relevance to our region, it is important to note that much of NAU’s research activity is not limited to the Colorado Plateau, Native American populations, or forest ecology and restoration. NAU faculty conduct cutting-edge research that is far more commonly national and international in scope. Our research strengths in biosciences, environmental sciences, astronomy, forestry, renewable energy, and applied linguistics have all brought significant international recognition to NAU.

In order to retain our leadership position in some research areas and achieve national prominence in others, we recognize that new ideas and strategies will be needed. It is evident that research activities at national and international levels are changing rapidly with the exponential growth of informatics, data science, and “big data” research. There are overwhelming amounts of new information being generated, collected, stored, and used in innovative ways to address new research questions. The new knowledge created from these research findings will reshape our views of the world around us and of the social groups that act in the world. It is essential that university faculty and students at all levels become well versed in these new research techniques and directions and that they become the primary contributors to this new research paradigm for the 21st century.

In keeping with this vision, NAU must develop major new capacity in informatics and computer sciences to support disciplinary research of many types and in many disciplines. Such a vision for research also

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**New Vice President for Research at Northern Arizona University**

Dr. William “Bill” Grabe, Regents’ Professor of Applied Linguistics, assumed the role of Vice President for Research on July 1st, 2012. He joined the faculty at Northern Arizona University in 1984 as an assistant professor. He has conducted extensive research in the fields of second language reading and writing development, language testing, and skills development for English as a foreign language. In his role as Vice President for Research, Bill seeks ways to increase research capacity and enhance NAU’s national research prominence.
ensures that NAU graduates will be highly competitive in new and changing job markets and become professional leaders in many existing and new fields. We expect our students and our faculty to be major contributors in this new direction in research, and the NAU Research Division will continue to work energetically to achieve this vision for the university.

Research at NAU results in new knowledge and generates outcomes that benefit society locally, nationally, and globally. Through our research enterprise, NAU faculty, staff and students collaborate with an international network of scientists and scholars. Very talented students choose to come to NAU to engage in research and scholarship that has broad, global significance. We recognize and proudly acknowledge the major research advances through which NAU receives national recognition.

Bill Grabe
Vice President for Research

(Left to right) Vice President for Research Bill Grabe, Director of Research Capacity Development and Professor of Biology Cathy Propper, and Director of the Office of Grant & Contract Services Winnie Ennenga discuss activity within the Division of Research.
Mimicking muscle responses

NAU lab investigates elastic properties of muscles for advancements in prosthetics

Decades-long research on the rapid tongue movement of frogs and toads has led to a patent-pending invention that could change the landscape of prosthetics. Regents’ Professor of Biology Kiisa Nishikawa discovered that the power of a toad’s muscle contraction stems from the spring-like protein called titin. With this discovery and the help of John Tester, Associate Professor of Mechanical Engineering, Nishikawa developed a bench model of a muscle-like actuator that can adapt instantly to sudden changes, something current prostheses cannot do. In addition to its application to prosthetics, this technology can benefit the field of bionics by providing self-stabilization during perturbations.

INNOVATION AT NORTHERN ARIZONA UNIVERSITY

Northern Arizona University encourages its faculty and students to make discoveries and create new knowledge. Customarily, these discoveries are disseminated through articles published in scholarly journals, posters presented at disciplinary conferences, and talks given at scholarly venues. However, another way that NAU disseminates the outcomes of research and scholarship is through technology development and commercialization, or “tech transfer.” In FY2012, the Office of the Vice President for Research established NAU Innovations, a branding of the university’s tech transfer operation that combines research development, intellectual property management, and technology commercialization activities.

NAU Innovations catalyzes discovery and manages the transfer of research outcomes from the university to the private sector for the benefit of regional, national and global communities. Innovations provides resources and technical assistance to NAU researchers from the earliest stages of IP development, helping to both generate and disseminate cutting-edge research results that can compete in the 21st century marketplace.
Making materials smarter

A new resin holds the key to storing charge in carbon composite materials

Carbon fiber composite materials are used in high-performance applications such as aerospace components, medical devices and sporting equipment. Constantin Ciocanel, Assistant Professor of Mechanical Engineering, imagines many more applications for these materials if they could only store electricity. Enter Associate Professor Cindy Browder, who has developed a resin that can interface with Ciocanel’s carbon-fiber stacks to enable power storage in carbon-based composite materials. Ciocanel imagines that these materials could be used to manufacture structures and devices such as aircraft sidewall panels, wind turbine blades or even laptop cases. He and Browder are thinking green as well—developing sustainable power-storing composites made from renewable materials.

Improving rapid prototyping in NAU’s CAD/CAM laboratory

The RAPIDLab (Realization of Advanced Products and Innovative Designs Laboratory) is part of the College of Engineering, Forestry, and Natural Sciences at Northern Arizona University. The lab supports both research and educational activities with machines that range from 3D printers to lathes and mills to create parts. In September of 2012, the lab acquired a new vertical mill from Haas Automation. The CNC Vertical Mill is a 5-axis machine and can be used create many parts. Along with flattening faces of large plates and placing holes our cutouts into the plates, the mill can help create complete geometric shapes, all with increased speed and accuracy.

TECHNOLOGY TRANSFER STATISTICS

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...break barriers

Research progresses the viability of using algae for commercial applications

Karen VanWinkle-Swift, Regents’ Professor Emeritus of Biology, is paving the way toward more efficient uses of algae in commercial products. Her research group is developing methods to support the growth and harvesting of algae that are faster and yield more cells in less space than the usual approaches. This project stems from her work germinating zygospores of algae as a source of abundant extractable lipid for use in lipid-related consumer products and biofuel. Despite the possibility that zygospores provide the richest source of lipid from *Chlamydomonas* (a common alga found in diverse environments), they have not been seen as commercially viable for biofuel because their heavily walled spores make oil reserves hard to access. VanWinkle-Swift has found a way to break this barrier by exploiting and manipulating the life cycle of a lesser known species of algae. This discovery comes at a prime time as interest in algal biodiesel production is increasing.
Mary McGroarty (left) and Okim Kang (right) at the 2012 RCA reception

Okim Kang received the 2012 Research and Creativity Award (RCA) for “Most Promising New Scholar” in October 2011. Kang received the award for achievements in applied linguistics—specifically, for her innovative work in the area of spoken-language assessment for teaching and learning English as a second language and in acquisition of English language skills for non-native speakers. The award was presented to Kang by Mary McGroarty, Professor in Applied Linguistics. Dr. Kang’s research aligns with several of NAU’s strategic goals, by addressing language identity issues with language minority and dialect minority students on campus.

...watch the skies

A look at near-earth objects sheds light on our planet and solar system

Sending astronauts to an asteroid sounds like something you would see in a science fiction movie, but research being done at NAU is bringing us closer to making that a reality. David Trilling, Assistant Professor of Physics and Astronomy, is bolstering our knowledge of the physical characteristics of near-earth objects—bodies whose orbits bring them close to the Earth’s orbit—by examining the data from the Spitzer Space Telescope. Since very little has been previously known about smaller, more abundant near-earth objects, Trilling works to determine the sizes, temperatures, and albedos (how much sunlight an object reflects) of hundreds of these targets. Trilling’s observations show that asteroids have a greater degree of diversity than expected, indicating some could have origins farther out in the solar system. Trilling’s work could also reveal new clues about the formation of our solar system and how our planet evolved.
Carol Chambers, Professor of Wildlife Ecology in Northern Arizona University’s School of Forestry, is passionate about protecting bats. In FY2012, she organized a team from the United States and Canada to study bats on the Central American isthmus between Lake Nicaragua and the Pacific Ocean. This 12-mile stretch of land, with its once dense forests, is becoming increasingly fragmented, and Chambers was very concerned about how the changing habitat was affecting bat populations. Over 10 weeks, they netted, documented, and released nearly 1,800 bats representing 49 different species. But Chambers’ most remarkable discovery was catching the rare pale-faced bat Phylloderma stenops, one that her Nicaraguan colleague, Arnulfo Ramon Medina Fitoria, had been trying to find for 11 years. The large bat, with its short brown fur and long, gray, white-tipped wings, was a newly-recorded species for the country. Chambers also participated in a local bat conservation campaign to help Nicaraguan farmers appreciate the ecological benefits that bats provide, such as eating harmful insects and pollinating forest plants. In Arizona, Chambers researches bat mortality associated with wind turbines using genetics analyses. With distribution models, she estimates population size and migration routes, thereby generating more realistic mitigation thresholds for wind energy developers.

Former student regent targets antifungal compounds in dissertation research

With her two-year appointment as a student regent having ended in 2011, Jennifer Ginther’s life as an NAU doctoral student in biology and researcher in the Center for Microbial Genetics and Genomics (MGGEN) keeps her busy every day. Ginther conducts research on the population structure and phenotypic characterization of Burkholderia pseudomallei, a soil-dwelling organism and the causative agent of melioidosis. Melioidosis is endemic in Northern Australia and Southeast Asia and is the cause of up to 20% of all community-acquired...
...study wildlife disease

Whole genome analysis improves our understanding of avian cholera dynamics

*Pasteurella multocida* causes avian cholera, the most lethal and common infectious disease affecting Northern American wild migratory birds. The disease is newly emerging in parts of the Canadian Arctic and East Coast, increasing outbreaks of the infection and of mortality. To help understand the dynamics of cholera outbreaks, predict patterns, evaluate risks, and develop effective disease management, Jeff Foster, Assistant Research Professor in Biological Sciences and Associate Director of the Center for Microbial Genetics & Genomics, used Multi Locus Sequence Type genotyping and whole genome analysis to genetically characterize *P. multocida* isolates. Environment Canada, an organization that works to preserve and enhance the quality of Canada’s natural resources, provided his lab with avian and environmental samples for evaluation. Foster successfully ran comparisons of *P. multocida* strains in relation to each other and to other published strains. This work was an extension of previous years’ work on developing more efficient and sensitive screening tools and evaluating markers for comparing the strains.

blood infections in these endemic regions. Ginther’s goal in her dissertation is to understand the genetic population structure of *Burkholderia* species in the endemic region of Northern Australia and also to investigate the antifungal properties of *B. pseudomallei* and close genetic relatives. Ginther has identified several novel species of *Burkholderia* from Northern Australia during her studies and will be published in 2013. In the spirit of MGGEN’s dedication to training undergraduate students, Ginther involves an undergraduate in her research to assist in performing cloning reactions and analyzing genomes. Her research has the potential to identify novel antifungal compounds that could be used as drug targets against fungal diseases such as Valley Fever. Ginther is well on her way to building a career in science and technology policy to address political and social issues afflicting our nation and world.
A new program places value on the character and behavior of the future workforce

Timothy S. Clark, Assistant Professor in The W. A. Franke College of Business at Northern Arizona University (NAU), spearheaded development of the Professionalism Recognition Program (PRP) for undergraduate business students. “The PRP was established to promote, evaluate, recognize, and reward the professional conduct of students within and beyond the curriculum in a flexible and widely applicable way,” notes Clark. Developing professionalism has implications far beyond the classroom. Research has shown that employers value candidates’ character and behavior at least as much as their technical knowledge. Being more professional should give business-school graduates an edge in the job market while developing their character and conduct. “One year since its pilot semester, nearly 500 students have voluntarily enrolled, which is approximately one-third of those eligible, but appropriately skewed toward upperclassmen. Faculty participation has risen to nearly one-half, also appropriately skewed toward upper-division courses,” reported Clark at the 2012 conference of the Western Academy of Management. “This comprises a critical mass that has the program’s administrators feeling it is already viable and that its value is likely to grow for the benefit of students, faculty, and employers.” The next research steps are to develop a definitive, workable model of professionalism based on employer surveys and focus groups.
Undergraduate Research

The engagement of undergraduate students in authentic and meaningful scholarly, creative or research experiences is a priority at Northern Arizona University. The university provides several ways for undergraduate students to fund their work and gain these experiences. The Office of the Vice President for Research (OVPR) administers three programs that provide financial support for undergraduate (and graduate) research: the Hooper Undergraduate Research Award (HURA), for student-initiated projects; the Hooper Sustainability Award, for sustainability projects on campus and in Northern Arizona; and Student Travel Awards, a program which provides funding to help make it possible for students to present their work, accept awards, or participate in academic competitions at regional, national, or international meetings and conferences.

In FY 2012, the OVPR provided 22 awards through the Hooper Undergraduate Research program and 204 Student Travel Awards for a total of $129,130. The OVPR hosted the first annual Hooper Awards Poster Presentations and Reception in April 2012 to celebrate the achievements of the Hooper Sustainability and Hooper Undergraduate Research Award recipients. Twenty-eight students discussed their research posters with Dr. and Mrs. Henry Hooper and 45 other invited guests.
Joshua Mayoral, a Biomedical Science major, earned a spot on the Student Undergraduate Research Council and received the 2nd place award for his research internship at the 19th annual College of Engineering, Forestry, and Natural Sciences Undergraduate Research and Design Symposium in April 2012. These achievements are in recognition of the research that Mayoral has done on the role played by mucus during infection of *Toxoplasma gondii*. This intestinal parasite, which is excreted by cats in their feces, causes toxoplasmosis. Mayoral’s study fills research gaps by investigating whether *T. gondii* induces or reduces mucin gene expression. This new information could lead to research on other parasite-mucin interactions and may lead to the development of new therapeutic methods. Mayoral found that the prevalence of certain mucin proteins, the main components of mucus, increased in intestinal cells of mice during infection. Is this result also true in humans? Mayoral will investigate this as part of his 2013 Hooper Undergraduate Research Award.
NAU student-researchers present their work at the National Conference for Undergraduate Research

Nine NAU students, majoring in everything from anthropology, to physics, presented their research at the National Conference for Undergraduate Research (NCUR), held at Weber State University, March 29 to 31, 2012.

(left) Meagan Seymour studied anthrax-contaminated heroin to determine its source. (right) Sophomore Rebeca Kinser explained her project examining crater typography on the moon. She said, “My favorite question came from a young boy who asked me, ‘Do you think we’ll ever live on the moon?’”

Students from 333 institutions of higher education in seven countries and 46 states traveled to Ogden, Utah, to disseminate their scholarly, creative, or research work. More than 3,100 registrants presented 2,759 projects across all disciplines. MaryLynn Quartaroli, Undergraduate Research Coordinator in the Office of the Vice President for Research, concurred by saying, “The students were enthralled and inspired by the keynote speakers for this event: a Nobel laureate in physiology, a National Book Critics’ Circle award winner, and a Goldman Environmental Prize winner.”

“The most memorable aspect of the conference,” said NAU junior Kylie Sage, “was seeing how diverse and creative research can be. People did studies on things that I never would have thought about, and it was very impressive. One of the highlights for me was talking to others doing similar research as my partner and me. We bounced ideas off of each other and got to hear different perspectives on the same topic.”

NAU student presentations at NCUR: from astronomy to anarchism

- **Kelly Atwood** (history major): “Early Twentieth Century Anarchism as a Cultural Movement.” [Faculty advisor: Leilah Danielson]
- **Andrew Belus** (microbiology major): “How Are Microbial Rhizosphere Communities Affected by Water Availability?” [Faculty mentor: Nancy Johnson]
- **Bret Clawson** (chemistry for health professions major): “Developing Genetic Markers for Fleas that Vector Plague (Yersinia pestis).” [Faculty mentor: David Wagner]
- **Valerie Gibbs** (astronomy major): “Crater Topography in the Southwestern Quadrant of the Lunar Nearside.” [Faculty mentor: Nadine Barlow]
- **Rebeca Kinser** (astronomy major): “Crater Topography in the Northwestern Quadrant of the Lunar Nearside.” [Faculty mentor: Nadine Barlow]
- **Meagan Seymour** (biomedical science major): “Genomic and Genotypic Analysis of Heroin-Associated Bacillus anthracis (Anthrax).” [Faculty mentor: Talima Pearson]
- **Michael Talbot** (physics/astronomy major): “Geological Analysis of Impact Craters to Study Terrain History and Signs of Water in Arabia Terra, Mars.” [Faculty mentor: Nadine Barlow]
- **Amanda Webber** (anthropology) and **Kylie Sage** (anthropology/biology major): “Using Isotopic Analysis to Investigate Migration as a State Strategy in the Ancient Andes.” [Faculty mentor: Corina Kellner]
### 2008-2012 SPONSORED PROJECT EXPENDITURES BY ACTIVITY TYPE

*Values are in thousands of dollars*

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*Values are in thousands of dollars*

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### 2008-2012 RESEARCH EXPENDITURES


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*Values are in thousands of dollars*
WHO FUNDS RESEARCH AT NAU?

- Non-Profit Organizations
- Other Colleges and Universities
- Private, Industry, and Foreign Sponsors
- State Government
- Local Government
- Federal

FEDERAL SPONSORS
- U.S. Department of Education
- National Science Foundation
- Forest Service
- Environmental Protection Agency
- Corp. for Nat’l & Community Service
- National Institutes of Health
- Other Federal
WHAT DO THEY FUND?

- Research: 43% ($20,439K)
- Public Service: 38% ($18,193K)
- Instruction and Other Support: 19% ($8,881K)

2012 AWARDS BY UNIT

- W.A. Franke College of Business: $206,500
- College of Education: $295,056
- College of Health and Human Services: $950,433
- College of Engineering, Forestry and Natural Sciences: $22,343,153
- College of Social and Behavioral Sciences: $8,482,664
- College of Arts and Letters: $264,978
- Administrative Units: $10,161,909
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