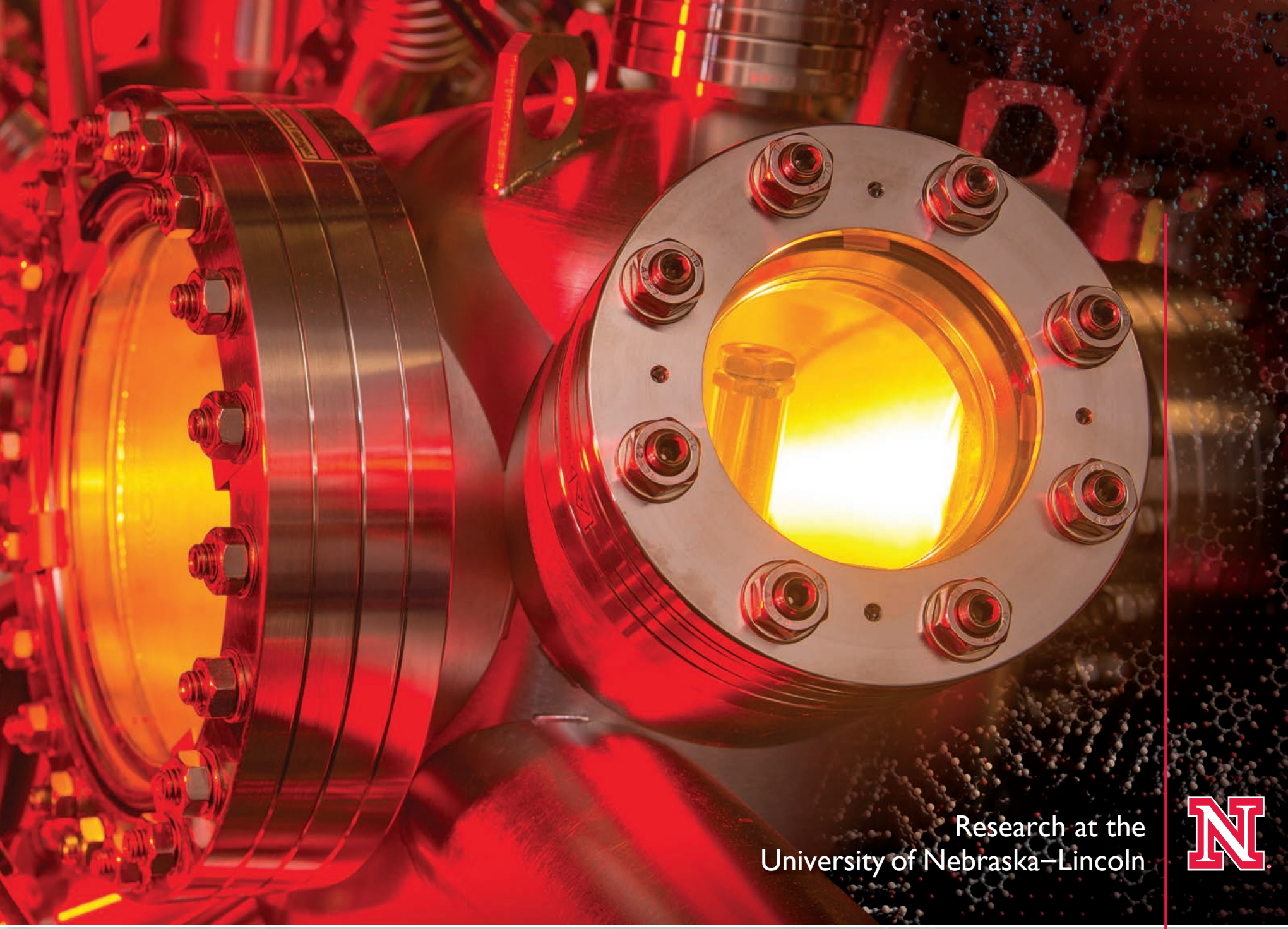

Research at the University of Nebraska–Lincoln

2014-2015 REPORT

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On the Cover
Advances fueled by nanoscience and materials research at the University of Nebraska–Lincoln are helping lay the foundation for a new generation of smaller, faster and more efficient electronics and computing technologies. Discoveries by physicists, chemists and engineers in the Materials Research Science and Engineering Center, funded by the National Science Foundation since 2002, have elevated UNL as a leader in nanomaterials research. The cover photo features a scanning probe microscope in the Thin Film Growth and Characterization Facility, a shared MRSEC laboratory for collaborative research on polarization and spin phenomena in nanoferroic structures. Using this microscope, researchers explore the atomistic origin of the physical properties of nano and hybrid structures. Read more about MRSEC on pages 2-5.

On the Web
Explore the 2014-2015 UNL Research Report website for more photos, links and videos related to stories in this report:

research.unl.edu/annualreport/2015

Investing in the Future

At the University of Nebraska-Lincoln, we're building for the future with strategic investments in key areas of traditional and emerging research strengths.

We believe in taking on big challenges as we build our research enterprise. Our approach: define the vision, seek and support talented people with ambitious ideas, give them the best facilities and the freedom to innovate and create, and pursue partnerships that extend our reach. And always build with the future in mind. This report highlights some of our successes and aspirations.

UNL's Materials Research Science and Engineering Center, featured on the report cover, exemplifies our philosophy. MRSEC grew from the vision of faculty leaders and two decades of targeted university investments in the people and infrastructure needed to be in the forefront of the emerging field of materials and nanoscience. Funded by the National Science Foundation since 2002, our MRSEC has grown into an internationally known research center. The payoffs are clear: major discoveries and advances in nanomaterials; strong partnerships with national laboratories, industry and international institutions; and nationally recognized education and outreach programs (page 2).

Our faculty's pioneering endeavors often ground our successes. UNL's National Drought Mitigation Center,

Chancellor Harvey Perlman (left) and Vice Chancellor Prem S. Paul

the leader in drought planning and management for 20 years, is now home to a new National Oceanic and Atmospheric Administration-funded Drought Risk Management Research Center. This center will provide research, data and information for drought planning, an increasingly critical need in a changing climate (page 20).

We're making more investments in the future. We launched our Social and Behavioral Sciences Research Consortium in 2015 to coordinate our expanding research in these areas (page 13) and work closely with our new NSF-funded Central Plains Research Data Center. Bold hiring initiatives underway in the Institute of Agriculture and Natural Resources and in our colleges will change the face and the focus of our research for years to come (page 30).

Partnerships are central to transforming our discoveries, knowledge and expertise into useful technologies and products that help drive economic growth. Our business and industry partnerships expanded in 2015 as the Food Innovation Center and Greenhouse Innovation Center opened at Nebraska Innovation Campus. This private-public research campus being developed adjacent to UNL is rapidly evolving from an audacious idea to a reality as more tenants – from established corporations to startups – move in.

At UNL, we welcome big challenges. We think they look like our best opportunities to make a positive difference for Nebraska, our nation and our world.

Prem

Prem S. Paul
Vice Chancellor for Research
and Economic Development

Research Driving Nanomaterials' Huge Potential

The semiconductors powering modern electronics are fast approaching their functional limits, threatening further advancements in computing technology.

Scientists and engineers in UNL's Materials Research Science and Engineering Center lead basic research needed to create a new generation of electronic and computing technologies.

UNL established this highly collaborative center in 2002 with a $5.4 million National Science Foundation grant. In 2008, NSF awarded $8.1 million to continue the center. A new $9.6 million grant funds its work through 2020.

"Ten years ago, it was hard to imagine how vigorously nanomaterials research would advance in Nebraska. Now, we are among the leaders in the field," said Evgeny Tsymbal, George Holmes University Professor of Physics and MRSEC director.

Major advances in understanding nanomaterials' unique properties underpin the center's success.

Now called Polarization and Spin Phenomena in Nanoferroic Structures, or P-SPINS, the center focuses on two key research areas. Each aims to create new nanomaterials to enable smaller, more powerful and energy-efficient computers and other electronics.

Magnetoelectric materials and functional interfaces research builds on UNL physicist Christian Binek's advances in spintronics and nanomagnetism. This team is developing voltage-powered logic and memory devices.

The second focus on polarization-enabled electronic phenomena evolved from Tsymbal's theoretical predictions and physicist Alexei Gruverman's experimental work on quantum tunneling through a nano-thin ferroelectric barrier. This team is investigating novel ferroelectric materials and structures to advance nanoelectronics.

MRSEC faculty also are developing more efficient solar cells, superior magnetic and nanoscale structural materials, and techniques to better understand nanomaterial properties.

Through the center, 18 UNL researchers from diverse disciplines share expertise. Faculty also collaborate with scientists nationally and internationally.

To transform MRSEC's discoveries into products, the center partners with industry. For example, faculty work with UNL's Center for Nanoferroic Devices, funded jointly by an industry consortium and the National Institute for Standards and Technology.

MRSEC also is known for its educational and outreach programs.

"I believe we now have the strongest, most coherent, most accomplished team yet," said Axel Enders, a UNL physicist and associate center director. "I have no doubts we're going to be awesome."

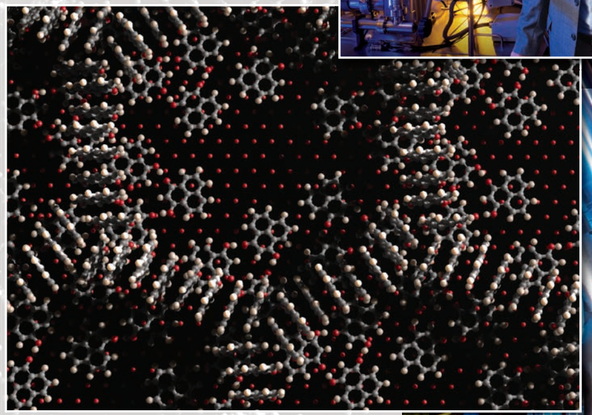
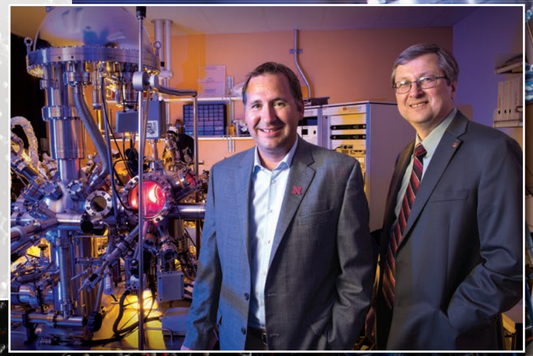


Illustration of 3-hydroxyphenalenone (3-HPLN) molecules assembled on a copper surface. MRSEC research showed that 3-HPLN molecules self-assemble into a network that enables them to stand upright.



Axel Enders and Evgeny Tsymbal

Graduate students Iori Tanabe (left), Zahra Ahmadi and Keith Foreman

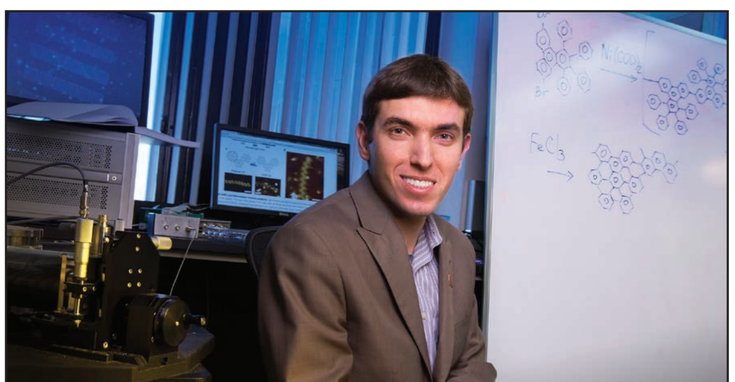
Putting Graphene to the Test

Graphene has the potential to improve electronics, solar cells and other devices. UNL chemist Alexander Sinitskii is testing this promising nanomaterial with a $538,500 National Science Foundation CAREER award.

He's capitalizing on a technique he developed to create atomically precise graphene nanoribbons, ultranarrow bands of one-atom thick sheets of carbon. The precision allows Sinitskii to create nanoribbons with different widths and edges. Now, he's investigating how these differing characteristics influence the nanoribbons' properties.

Understanding changes in nanoribbon properties will help Sinitskii and others design materials that improve performance in diverse applications, such as semiconductors, solar cells and fuel cells. He plans to develop prototype devices incorporating graphene nanoribbons.

Sinitskii is an affiliate of both UNL's NSF-funded Materials Research Science and Engineering Center and the Nebraska Center for Materials and Nanoscience.



Alexander Sinitskii

He's the latest MRSEC faculty member to earn a prestigious NSF CAREER award, which supports pre-tenure faculty who exemplify the role of teacher-scholars through research, education and the integration of education and research. Other MRSEC-affiliated CAREER award winners are:

- 2006-2012: Christian Binek, physics and astronomy, $500,000 for education and research on nanoscale spintronic systems and heterostructures. Binek leads one of MRSEC's research teams.
- 2008-2013: Axel Enders, physics and astronomy, $412,000 to study self-assembled magnetic nanostructures to improve data storage and other computing devices. Enders is MRSEC's associate director.
- 2009-2014: Eva Franke-Schubert, electrical engineering, $400,000 for research on hybrid chiral nanostructures to enhance computing, electronics and solar cells or batteries.
- 2012-2017: Xia Hong, physics and astronomy, $600,000 for work on nanomaterials with both magnetic and ferroelectric properties, which may lead to novel materials and devices.
- 2013-2018: Jinsong Huang, mechanical and materials engineering, $400,000 to study methods for increasing solar cell efficiency using organic polymers as a semiconductive material.

Consortium Targets Ultrafast Processes

When light strikes an object, it triggers atomic changes that happen too fast for scientists to observe. But UNL physicists are honing ultrafast techniques to decipher how light interacts with molecules, atoms and nanostructures.

Their discoveries could lead to much faster computers, more efficient solar technology and other enhanced light-based technologies, such as lasers.

"Ultrafast science is the next step in humanity's ability to understand nature and ultimately control these processes," said Anthony Starace, George Holmes University Professor of Physics.

UNL's physicists have partnered with colleagues at Kansas State University and the University of Kansas in a Nebraska-Kansas Consortium that expands all three universities' capacity to study atomic, molecular and optical physics.

The consortium is taking two approaches to observe ultrafast processes. The first is based on stop action made famous by 1925 Nebraska alumnus Harold Edgerton and his iconic image of a bullet piercing an apple. Today, scientists use superfast electron and laser pulses instead of strobe lights.

UNL physicists are designing and building a new source of electron pulses that uses high-powered lasers to accelerate electrons even faster. The souped-up equipment will be housed in UNL's Extreme Light Laboratory.

From left, Anthony Starace, Martin Centurion and Herman Batelaan

The device also may help elucidate transformations in solids, which could open new avenues in materials science research.

The second approach uses light pulses to overcome electronics' relatively slow speed. Merging light with the electrons used in electronics may result in much faster computers and other devices.

The consortium also will provide educational and outreach activities to small Nebraska and Kansas colleges and students underrepresented in science and engineering.

Thirteen UNL physicists and engineers participate in the consortium. Starace and physicists Herman Batelaan and Martin Centurion lead UNL's participation.

The National Science Foundation's Experimental Program to Stimulate Competitive Research, or EPSCoR, funds the consortium with a three-year, nearly $6 million award, of which UNL received nearly $3 million. It is one of three science and engineering consortia funded by the program nationwide.

Making Solar Energy More Affordable, Efficient

Solar energy remains tantalizingly out of reach as a widely used power source, but a UNL engineer is making big strides in his quest to harness the sun.

Current silicon-based solar cells are too expensive and inefficient, said Jinsong Huang, Susan J. Rosowski Associate Professor of Mechanical and Materials Engineering. "Our target is to reduce solar cell costs by half, so it can compete with energy from fossil fuels."

He's attacking that goal on several fronts with grants of more than $1.2 million from the U.S. Department of Energy and $2.6 million from the National Science Foundation.

Perovskites, a class of abundant crystalline compounds, are a promising solar cell material that potentially could cost a thousand times less than silicon, Huang said.

His evolving techniques are helping to set records in perovskite solar energy efficiency. Thanks to his and others' advances, the material now rivals silicon's 20 percent energy efficiency and promises greater improvements.

Huang and his team also created a single, large perovskite crystal using a low-cost fabrication technique. They demonstrated the material's potential capacity as a sun catcher is thousands of times greater than previously reported. Their findings, published in *Science,* provide insight into future improvements. Huang continues to study what makes perovskite crystals so exceptional.

He's also investigating a new fabrication technique to make inexpensive, large-scale solar cells for a variety of applications.

Perovskite degrades easily so more research is needed before it can replace silicon.

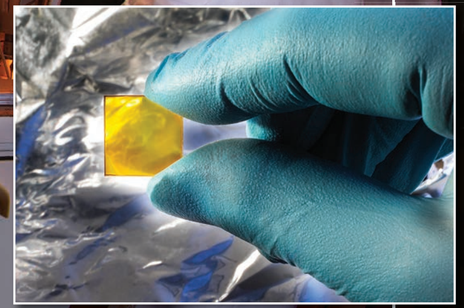
As an intermediate step and to take advantage of established technology, Huang is investigating ways to overlay silicon with an ultrathin film of perovskite to increase current solar cell efficiency.

Another major solar cell avenue replaces silicon with less expensive organic polymers, or plastics, which are cheaper and more flexible, but also less energy efficient. Huang continues exploring ways to improve organic polymer semiconductors.

"Renewable energy is the No. 1 issue for the future," Huang said. "Solar energy still has a relatively long way to go, but the path is clear to me. I firmly believe renewable energy will one day be a major energy source."

Jinsong Huang and colleagues in his lab

Single crystal perovskite



UNL research shows fabricating an organic solar cell on a nonwetting plastic surface makes it 1.5 times more efficient at turning sunlight into energy.

"Our target is to reduce solar cell costs by half, so it can compete with energy from fossil fuels."

Reducing High Costs of Harnessing the Wind

As every Nebraskan knows, wind can pack a powerful punch. Wind turbines, which capture all that energy, routinely suffer the wind's abuses.

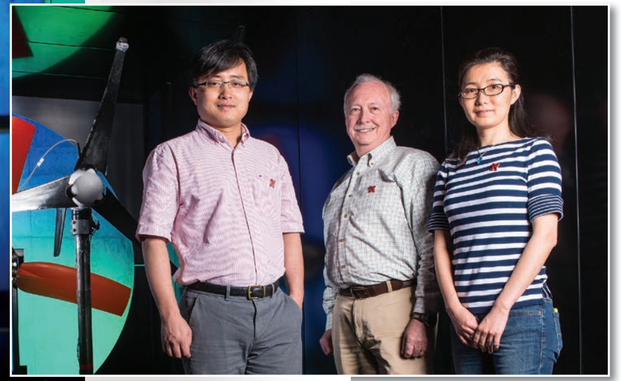
Maintaining turbines significantly increases the cost of wind power. A UNL team, in collaboration with GE Global Research, is developing technology to reduce that cost. Supported by a $1.5 million U.S. Department of Energy grant, the project will help the nation capitalize on an important renewable energy source.

"Wind turbines operate under harsh conditions and require frequent inspections," said project leader Wei Qiao, associate professor of electrical and computer engineering. "The cost of wind energy is very high, so we want to develop a system to reduce maintenance costs and extend the life span of wind turbines."

Currently, maintenance requires a technician to head to remote, sometimes offshore, locations to scale turbines and inspect them manually. Finding a turbine in working order wastes time, but a damaged turbine not caught early enough often leads to more extensive and costly repairs.

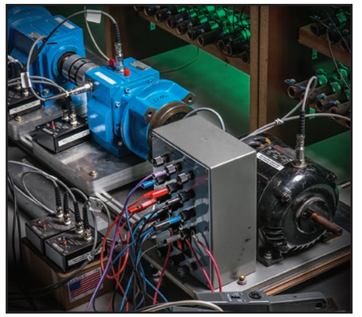
UNL engineers are developing a system to remotely monitor, in real time, turbine function and to predict deterioration before it fails. The information will help operators and maintenance personnel better schedule inspections and repairs.

Traditional turbine monitoring systems use vibration sensors and other expensive equipment that also require maintenance and can fail.



Above: Electrical engineers Wei Qiao, Jerry Hudgins and Liyan Qu

Left: Wind turbine



Test gearbox and data acquisition system

To keep costs low, UNL engineers are piggybacking on control sensors already built into turbines. The challenge is finding and extracting only the information indicative of turbine health from within that larger data stream.

Qiao's team is using signal-processing technology to develop ways to detect faults and predict their development over time using relevant electrical signals.

They plan to make a prototype system and test it on wind turbines installed at Nebraska high schools and community colleges. Collaborators at GE, the largest U.S. wind turbine manufacturer, will evaluate the system on larger wind turbines at sites nationwide.

This is part of Qiao's broader research to improve wind turbines and smart power grid technologies. The National Science Foundation also funds this research.

Transforming Life Sciences Learning

Taking apart the family radio has helped generations of budding engineers learn. Now, a UNL team is giving future biologists the gift of tinkering.

They're developing educational tools to help the next generation of biologists better understand complex biological systems and to prepare them for a rapidly changing research field. Ultimately, with support from a $2.3 million National Science Foundation grant, the team aims to transform the way biology students learn.

The life sciences, from the molecular to ecosystem scale, increasingly rely on computational and mathematical models to make sense of complex networks operating within an entire biological system. Yet biology students still largely learn by memorizing facts from textbooks, which limits their understanding of how dynamic systems function.

"There's this feeling about introductory classes that we need to cram as much knowledge in as we can," said Joe Dauer, assistant professor of life science education in UNL's School of Natural Resources. "Eventually we want them to come out and be systems thinkers. We're trying to get them thinking about biological systems earlier."

Dauer teamed with biochemist Tomas Helikar and colleagues to develop educational software that simulates biological processes, such as cellular

Tomas Helikar and Joe Dauer (center) with postdocs Heather Bergan-Roller, Bhanwar Lal Puniya and student worker Greyson Biegert

respiration or population growth, and lets students manipulate – or rewire – a virtual system to see what happens. It's similar to how engineers and software programmers learn.

These educational tools stem from Helikar's previous work developing biological systems modeling software for researchers. Testing the models on students, he noticed they learned biology much more effectively than in the classroom.

"With these models, they can learn about the realistic complexity of these systems by being able to manipulate much larger networks or set of pathways that all work together," Helikar said.

The tools also will help students better understand the math behind data analysis techniques widely used in today's biological research.

The team is developing a library of educational materials for UNL students and plans to make them available to universities worldwide.

Assessing School Environment and Student Performance

Could that humming HVAC system in the classroom be harming kids' ability to learn? What about fluorescent lighting or lingering formaldehyde in furnishings?

An interdisciplinary UNL team aims to find out. It's one of seven research groups chosen nationally to receive $1 million each as part of the U.S. Environmental Protection Agency's Healthy Schools initiative.

"Look at the hours that students spend in school; we all want healthy buildings for them. Can we get some hard evidence-based data that show that indoor environments impact health and achievement?" asked project leader Lily Wang, a professor in the Charles W. Durham School of Architectural Engineering and Construction at the Peter Kiewit Institute in Omaha.

Wang studies the effects of acoustics. She's joined by Durham colleagues Clarence Waters, a lighting expert, and Josephine Lau, an indoor air quality expert.

The trio will gather detailed environmental measurements from more than 200 Nebraska classrooms over time. Then, educational psychologist Jim Bovaird will use sophisticated statistical tools to correlate each condition as well as the complex interplay of conditions with student performance on standardized tests.

Bovaird directs the Nebraska Academy for Methodology, Analytics and Psychometrics within UNL's Nebraska Center for Research on Children, Youth, Families and Schools.

The team also is using these statistical methods to analyze California public schools. California maintains databases on the conditions of many schools and on student achievement. Correlating the datasets will provide insights into how the buildings' environmental conditions affect achievement.

After analyzing the Nebraska schools' data, the team will oversee renovations of several schools to see what, if any, changes improve academic performance.

Researchers will share the results with schools to help officials prioritize future upgrades. And they will work with a school design company to help ensure that results are incorporated into plans.

"This initiative could be a game changer in five years," said Wang.

Lily Wang and Jim Bovaird

Searching for Rural Drug Prevention Strategies

Roughly 80 percent of injecting drug users in rural Puerto Rico have hepatitis C, and about 7 percent have HIV, a UNL sociologist has found. Kirk Dombrowski is using his expertise in studying how people form social connections to explore how drug users' social lives influence disease spread.

Ultimately, this research should identify effective prevention strategies for rural areas. This work is part of UNL's Minority Health Disparities Initiative, which targets understudied health issues.

"The bulk of the interventions used to prevent the spread of HIV, for example, are designed for urban areas," said Dombrowski, who heads the initiative. "Puerto Rico makes a nice test case for other rural areas, especially when we look at Native American populations, which have much higher hepatitis C rates than most."

Dombrowski and collaborators are surveying Puerto Rican drug users to understand how they form social relationships and communicate information. Computers help analyze how social networks evolve over time in relation to risky behavior. This information will help researchers identify effective interventions. A $2.9 million, five-year grant from the National Institutes of Health's National Institute for Drug Abuse supports this work.

In a different setting, Dombrowski is using similar social network analysis to study suicide prevention strategies in Alaskan native populations, where suicide rates, like those in Midwestern native populations, are high. He collaborates with University of Massachusetts Amherst colleagues on this work funded by NIH's Institute for Mental Health.

"Social network analysis is an innovative method that we feel could go a long way toward helping us understand what is and is not working," Dombrowski said.

UNL's Minority Health Disparities Initiative also is training the next generation to use social network analysis to solve minority health issues. In summer 2015, it hosted 10 undergraduates from around the nation who studied and worked with UNL research mentors. This new program, funded by a National Science Foundation Research Experience for Undergraduates grant, is the nation's only REU to explore minority health disparities.

"Social network analysis is an innovative method that we feel could go a long way toward helping us understand what is and is not working."

Kirk Dombrowski

New Consortium Coordinates Social, Behavioral Sciences Research

A new consortium aims to expand UNL's social and behavioral sciences research.

Launched in spring 2015, the Social and Behavioral Sciences Research Consortium is connecting researchers campuswide and coordinating research efforts and opportunities.

"We have a lot of talented people on campus engaged in social science research. We need more efficient ways to connect them so they can collaborate with each other," said sociology professor Dan Hoyt, who directs the consortium.

To encourage broader collaborations, the consortium will identify resources campuswide, build a research and referral network, identify and facilitate collaboration opportunities, provide seed funding, coordinate external funding opportunities and offer new faculty mentoring. The consortium works closely with UNL social and behavioral sciences researchers, centers and initiatives, such as the Minority Health Disparities Initiative and the new regional Central Plains Research Data Center.

Identifying UNL's social science assets is a key first step. The consortium is developing a comprehensive inventory of who's doing social sciences research, what they're studying, who they're working with and what they're interested in.

Dan Hoyt

"We know we already have assets," Hoyt said. "We're taking a network-science approach to figure out who's doing what and where capacity is."

The consortium grew from a faculty-led initiative launched by the Office of Research and Economic Development to explore ways to bolster social and behavioral sciences research.

"Bottom line, the measure of our success will be increased research funding and greater capacity in social and behavioral sciences at our university," Hoyt said.

Measuring Effectiveness of Program for Ojibwe Youth

While many American kids experiment with alcohol and other substances, American Indian children often begin younger. This early start increases their likelihood for substance abuse, other risky behavior and poor grades.

UNL emeritus professor of sociology Les Whitbeck and colleagues will evaluate the effectiveness of a popular substance abuse prevention program for Ojibwe children and their families. They received nearly $3.6 million to conduct a multi-reservation, randomized controlled trial – the gold standard of evaluation – from the National Institutes of Health's National Institute on Drug Abuse.

Les Whitbeck

Whitbeck developed the program, called Bii-Zin-Da-De-Dah, or Listening to One Another, nearly 20 years ago and has continued to adapt it.

The program aims to delay the onset and reduce the amount of substance use by bringing together groups of pre-teen kids and their families. Children learn social skills, such as coping with peer pressure and anger stemming from discrimination – two significant risk factors. Adults learn parenting skills.

A strong cultural component is also key. Historical and cultural losses have stripped away protective features of American Indian culture, such as community support.

"The kids and parents like having quality time together, but we don't know if it actually prevents anything," Whitbeck said. "This is a chance to demonstrate whether or not it has an impact on problem behaviors, particularly on alcohol and drug use."

The team will conduct pre- and post-program surveys for three years to compare program participant and non-participant families on five Ojibwe reservations in northern Minnesota and Wisconsin. Surveys will measure when kids begin using drugs and alcohol, as well as other risk factors.

Puzzles and games that help families connect with their culture are part of the Bii-Zin-Da-De-Dah, or Listening to One Another, program.

Ojibwe, or Anishinaabe, communities were heavily involved in the program's development and will continue to participate in the trial. Other collaborators include the University of Minnesota and Iowa State University.

Popular among families and tribal communities, the program has been widely disseminated and adapted by other tribes and bands throughout the U.S. and Canada.

Investigating Climate's Groundwater Impact

When droughts ravage agriculture, the role of climate change grabs headlines. But the climate's impact on groundwater quality as food production adapts to a warming planet receives less attention.

An interdisciplinary team of UNL researchers is investigating the climate's effect on groundwater contamination from chemicals used in crop and animal production, including indirect effects from land use changes.

"We were surprised at how little information there is about how climate will impact groundwater quality," said project leader Shannon Bartelt-Hunt, an associate professor of civil engineering based at the Peter Kiewit Institute in Omaha.

UNL climate change and groundwater quality team, from left: Yusong Li, civil engineering; Zhenghong Tang, community and regional planning; Shannon Bartelt-Hunt and Xu Li, civil engineering; Dan Snow, Nebraska Water Center; and Eric Thompson, economics. Not pictured, David Rosenbaum, economics.

The researchers are focusing on atrazine, a widely used crop herbicide, as well as the antibiotic sulfamethazine and artificial hormone estrone, both used in animal production. Atrazine is applied directly to fields, while the other two may be in manure applied as fertilizer.

They're investigating how different climatic conditions affect the compounds' behaviors and how they infiltrate soil.

To study climate's indirect effects, they're developing economic models to understand how predicted climate changes will affect land use.

"We expect that climate change, in addition to directly affecting the environment, will also directly affect human behavior," said economist Eric Thompson. "Those changes in human behavior will then also change water quality."

Decreasing water availability in the southern Plains is expected to concentrate crop and animal production farther north, including in Nebraska, intensifying the use of these compounds. This ultimately could harm groundwater quality.

"We hypothesize that those land use changes will have a greater impact than any direct effects of climate," Bartelt-Hunt said.

The team is creating a model linking economic and hydrological components that researchers and decision-makers can use to evaluate the effects of climate and land use changes on groundwater hydrology.

A $600,000 Water Sustainability and Climate Program grant from a joint National Science Foundation-U.S. Department of Agriculture program funds this interdisciplinary project, which includes engineers, economists, water scientists and regional planners.

Finding Poetry Amid Historic News Pages

Today, exposure to poetry often ends with graduation. But in the 19th century, poetry was broadly popular, appearing prominently in newspapers and influencing American society.

The difficulty of culling millions of poems from historic newspapers has left a gap in this important aspect of historical research.

To recover the poetry, a collaboration between UNL Libraries and computer science is developing a unique indexing and retrieval method based on visual cues rather than text. The technique may open new possibilities in searching for interesting patterns in other large datasets.

"With the current methods of searching these historic newspapers, there's no good way to get at the poetic content," said Elizabeth Lorang, research assistant professor with the Center for Digital Research in the Humanities. "By narrowing down the millions of poems that were published to those by just a handful of authors, we skew our understanding of how poetry functioned for everyday people."

In browsing historic newspapers, Lorang realized she was finding poems by cueing on visual distinctions on the page, such as white space and formatting. She teamed with computer scientist Leen-Kiat Soh to see if a computer could be trained to find poems within the millions of newspaper pages digitized for Chronicling America, a Library of Congress and National Endowment for the Humanities project.

Elizabeth Lorang and Leen-Kiat Soh

The pair, working with undergraduate students, developed a program that does just that, proving that image-based analysis works well. The method addresses challenges of using text-based approaches on historic documents, such as illegible text.

"We're modeling how human vision finds things," Soh said. "Even if you don't understand the language or can't read the text, you can still find the poem visually, which should help us archive and search texts more efficiently."

The technique could be used for other newspaper items, such as sports scores and advertising, as well as on modern digital archives.

Lorang and Soh plan to create a database of poems linked to Chronicling America.

The NEH funds their research.

Seeking a Cure: Tracking Molecular Clues to ALS

Oleh Khalimonchuk took the ALS Ice Bucket Challenge. But the UNL biochemist is doing much more to fight the devastating neuromuscular disease than taking a freezing shower for charity.

He and his team are investigating a promising lead on one of the causes of amyotrophic lateral sclerosis, or ALS, and other degenerative diseases, with a nearly $1.4 million, five-year grant from the National Institutes of Health. Their research may lead to effective therapies to fight these currently incurable, age-related diseases.

"We're trying to find a cure," said Khalimonchuk, a member of UNL's Redox Biology Center. "ALS is a devastating neurological disorder, so this is of really high significance."

Researchers now believe ALS develops in the mitochondria, a cell's power supply center. In generating energy, mitochondria create toxic free radical molecules that are mostly neutralized. Some of these molecules slip through, however, and cause damage that accumulates over time.

Eventually, free radicals can disrupt mitochondrial function, leading to degenerative muscular and brain diseases, such as ALS, Parkinson's and Alzheimer's. To prevent that from happening, mitochondria have a quality control system that's not well understood, but seems to malfunction in some people.

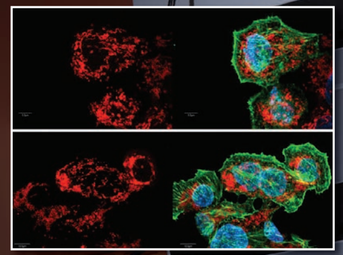
"This is whole new territory," Khalimonchuk said. "There's more and more appreciation toward the mitochondria being the culprit in lots of these aging-related degenerative diseases. We're trying to understand how mitochondrial welfare is maintained."

His team was one of the first to link a mutation in the protein Oma1 to ALS. Now they're exploring the protein's role.

They've learned, for example, that Oma1, which is dormant under normal conditions, activates during toxic stress and promotes a series of survival responses.

"We're making good progress," Khalimonchuk said. "Understanding this at the molecular level will help us to develop efficient treatment strategies."

Funded by NIH's Institute for General Medicine, this research has implications for understanding and funding therapies for other diseases, such as certain cancers, he said.



Model to study dysfunction in the Oma1 protein

Oleh Khalimonchuk

Planning for the Inevitable: Drought Mitigation Center's Strategies Help Reduce Impacts

The parched fields, dying orchards, disappearing reservoirs and first-ever mandatory water restrictions during California's drought grabbed the nation's attention this year. But climate scientists at UNL's National Drought Mitigation Center have been training governments and institutions to plan and prepare for such disasters since 1995.

"The primary reason we formed the NDMC was to focus on how we could better prepare for drought and mitigate its effects," said Donald Wilhite, founding director of the NDMC. For 40 years, Wilhite has studied the best strategies to cope with drought's complexities. While the NDMC is widely known for its role in producing the weekly U.S. Drought Monitor map, its mission is much larger.

Preparedness – developing plans to manage drought risk, rather than responding in the midst of crisis – is essential. "When I started working in drought there were three states with drought plans; now there are 47, with 11 states focused on preparedness," Wilhite said.

Climate change is bringing a renewed focus and sense of urgency to drought planning. In June 2015, the National Oceanic and Atmospheric Administration announced a three-year, $2.4 million grant to establish the Drought Risk Management Research Center at UNL. The center, which will be a part of the NDMC, will provide research, data and information for drought planning.

"The emphasis on research will help us address critical needs related to drought monitoring, impact assessment and planning strategies," said Michael Hayes, current NDMC director. A major goal is helping states, tribes and other entities become more resilient to future droughts, he said.

The NDMC has been a catalyst for change in the U.S., but its larger legacy may be international.

Because it is the only center of its kind in the world, countries from Africa to the Middle East, Europe and Latin America seek its expertise. The NDMC has worked on six of the seven continents, training scientists in drought-monitoring techniques, conducting drought-planning workshops and consulting with governmental agencies. Instead of responding in the midst of crisis, countries now ask how they can prepare for drought.

"That is a paradigm shift that has happened because Don, and then the NDMC, have been driving the message home for 30 years," Hayes said.

Above: Drought-stunted corn
Left: Donald Wilhite and Michael Hayes

More Partners Settle into Innovation Campus

Momentum abounds at Nebraska Innovation Campus as more UNL researchers, students and private partners settle into state-of-the-art facilities.

Doors opened in mid-2015 at the much-anticipated Food Innovation Center and the Greenhouse Innovation Center, attracting new tenants and partnerships on the private-public research campus being developed adjacent to UNL.

The Food Innovation Center, designed to be a leading food industry resource, now houses UNL's Department of Food Science and Technology and the Food Processing Center. It's also home to NIC's first corporate partner, ConAgra Foods, and other businesses. The 178,000-square-foot facility integrates the repurposed Industrial Arts Building with new construction.

Proximity to top food scientists and private businesses helped NIC become headquarters for the Nebraska Alliance for Advanced Food Sanitation, a partnership of food industry leaders Cargill, Commercial Food Sanitation, ConAgra, Ecolab, Hershey, Kellogg, Nestle and Neogen, and UNL food scientists. UNL is hiring a director to oversee the alliance, which aims to update industry sanitation protocols and equipment.

The Greenhouse Innovation Center is a boon to UNL plant scientists, and industry interest in using the facility is high, said NIC Executive Director Dan Duncan. The centerpiece of the 45,000-square-foot complex is one of the few publicly available LemnaTec Scanalyzer high-throughput phenotyping systems. Using this advanced digital imaging system, scientists can comprehensively study complex plant traits.

More growth chambers and conveyor belts are being added this fall, and office and wet lab spaces also are planned. The greenhouse expansion will wrap up Phase I construction at NIC ahead of schedule.

By late summer 2015, several Nebraska companies announced plans to move to NIC, taking advantage of opportunities to work closely with UNL faculty and students.

- Quantified Ag, the first startup company at NIC, is collaborating with UNL researchers involved in agriculture and big data.
- Food Dreams Made Real/Suji's Cuisine USA plans to open a research and development office. It is partnering with UNL's Food Processing Center to create quality precooked Korean foods to be sold at U.S. warehouse stores.
- NuTek Food Science also plans to open a research and development office, furthering an existing collaboration with the Food Processing Center to market "better for you" salt products.
- Metagenome Analytics LLC, NIC's first faculty startup company, provides bioinformatics expertise to the food and health sectors. Andrew Benson, W.W. Marshall Professor of Biotechnology, leads MGA with partners that include UNL faculty, postdocs and alumni.
- Intellifarm Inc., focused on technology solutions for agriculture, is partnering with UNL on research and offering internships for engineering and business students.
- Hastings HVAC is expanding its scope by conducting pollution remediation research at NIC.
- Echo Canyon Services, a data service and software company, is offering internships to attract student talent.

"This year has been the inflection point for Nebraska Innovation Campus," said UNL Chancellor Harvey Perlman. "NIC is a 15- to 20-year project to build economic competitiveness for Nebraska. With Phase I wrapping up and our recent grand opening, the foundation has been laid to make steady progress toward our goal of creating an innovation hub that enhances Nebraska's economy."

Postdoc research fellow Krishnamoorthy Pitchai in the new Food Innovation Center

Above: NIC's Greenhouse Innovation Center opened in spring 2015.
Main photo: UNL agronomist Harkamal Walia conducts research using the LemnaTec Scanalyzer high-throughput phenotyping system.

UNL Earns APLU Designation

The Association of Public and Land-grant Universities designated UNL as an Innovation and Economic Prosperity University in 2015, recognizing UNL's strong commitment to economic engagement.

The designation acknowledges universities that work to advance the economic well-being of their states and regions through research, education and engagement. UNL was one of 18 designees for 2015.

UNL's application highlighted its expanding research partnerships with industry; Nebraska Innovation Campus development; research and education opportunities for students; and statewide engagement through Nebraska Extension.

NIC, UNL an Ideal Fit for Growing Startup

Giving livestock producers and feedlot managers an easy-to-use, highly accurate tool to assess animal health and well-being is the idea behind Lincoln startup company Quantified Ag. UNL's Nebraska Innovation Campus and local business accelerator NMotion are helping chief executive officer Vishal Singh turn his idea into reality.

Quantified Ag is developing an ear tag sensor that collects data on cattle's biomarkers and behavior patterns. Producers and managers can remotely monitor cattle's physical condition and get immediate notifications when animals show signs of illness or stress, improving the odds of treating them before disease worsens or spreads. Some have dubbed the device "Fitbit for cattle."

In 2014 Singh completed the NMotion program, a mentoring and education accelerator for local startups. NIC and NUtech Ventures, UNL's technology development group, are NMotion partners.

Vishal Singh

Singh's mentors helped him start thinking like an entrepreneur. With a background in agricultural imaging, Singh was more comfortable building technology than considering commercial feasibility.

"What helped me was the idea that you shouldn't just try to sell what you can already do," Singh said. "You have to focus on your customer base and figure out how you can help them solve problems."

That realization led Singh to scrap his first idea of using drones to track biomarkers. Working with cattle producers and feedlot managers, he learned a drone could identify an area with stressed cattle, but finding a specific animal took detective work.

Cattle producers' responses to Quantified Ag's biometrics sensor idea have been overwhelmingly positive. Testing is underway and production plans are in the works.

Singh is eager for Quantified Ag's move to NIC in the fall. NIC has been an important partner, he said, providing marketing support and other resources. UNL faculty expertise in agriculture, food science and technology, and big data make NIC an ideal fit for the growing company.

"We'll be in the middle of it all," Singh said.

Legal Clinic Aids Entrepreneurs

The countless legal details involved with launching a business can be overwhelming and decisions have long-term consequences.

Student attorneys in the College of Law's Entrepreneurship Legal Clinic are helping position Nebraska startups for success, while gaining firsthand experience in transactional law.

Brett Stohs, the clinic's Cline Williams Director, established the clinic to meet local entrepreneurs' needs. The early stages of starting a business involve numerous legal decisions that owners may be encountering for the first time, including contract negotiation, employee hiring, regulatory compliance and protecting intellectual property.

Often, budgets and timelines are tight. The Entrepreneurship Legal Clinic pairs third-year law students with aspiring business owners seeking guidance on these and other issues. It's a win for both parties, said Stohs, assistant clinical professor of law.

"Our goal is to engage student attorneys and push them into a situation where they have to swim in a private firm setting. It's a great growth opportunity for them," he said.

Law students learn valuable lessons about culture, communication and client expectations that a classroom can't replicate, he said. Nearly 60 students have participated in the capstone program.

Brett Stohs

The Entrepreneurship Legal Clinic typically serves 12 to 15 clients each semester – and many more are waiting in line. When the clinic opened in 2013, most clients were from Lincoln. Now at least one-third come from rural areas, which allows students to learn how to assist clients remotely and expands the clinic's ability to serve Nebraska.

A range of practical experiences and the diversity of clients give students a clearer idea of what they can achieve professionally, Stohs said.

The clinic shares a tie with the NMotion business accelerator, a mentoring and education program for startups. Stohs is a program mentor, and several NMotion alumni have been clinic clients, including animal health and biometrics company Quantified Ag.

Philip Sapirstein

Above: A 3-D model of the Temple of Hera
Inset photos: Temple ruins; 3-D models of columns

Sapirstein photographs the temple in Olympia, Greece.

Digital Tools Reveal Ancient Architectural Details

Greece's ancient Parthenon and other Doric temples still inspire awe and disagreement. The origin of this oldest known Greek architectural style remains highly controversial in ancient Greek scholarship.

UNL art historian Philip Sapirstein set out to help challenge the prevailing theory of Doric origins using cutting-edge technology previously untested on an architectural scale.

Since the 19th century, scholars had largely accepted that Doric style had developed in wood, later to be replaced with stone. Many modern scholars question the theory's evidence.

Dubious as well, Sapirstein turned to the oldest well-preserved Doric structure, the 6th-century B.C. Hera Temple in Olympia, Greece, site of the original Olympic Games.

"The building is very important because it's a linchpin for this old theory of the Doric style," he said.

Using a high-quality camera and software that assembles 3-D models from 2-D images, Sapirstein created a virtual model of the temple, accurate to the millimeter. It's a modern spin on an old method of using photographs to take measurements.

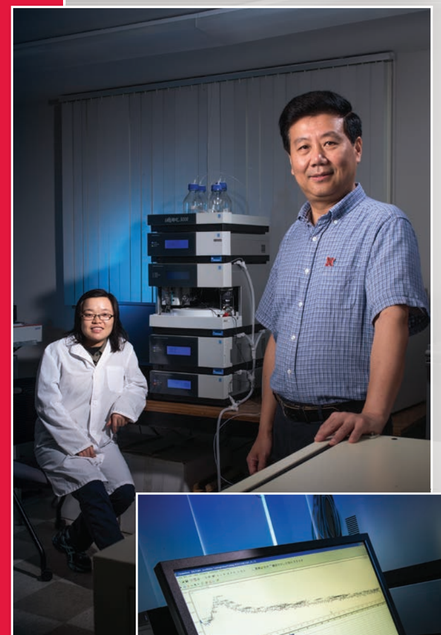
"The technique is great," he said. "It produces 3-D models very quickly and much more cheaply than you could using 3-D laser scanning hardware at this scale. It really opens up lots of possibilities."

Before this software was available, measuring a temple half a football field long would have taken at least a decade, Sapirstein estimated. Using the software, he completed the task in just two months.

His models have been accurate references as he reviewed 150 years of scholarship to refute the wooden-origin theory.

"It's hard to prove there wasn't a lost phase of something, like proving a ghost wasn't there," Sapirstein said. "But I found lots of evidence to support that the building didn't have wooden columns originally."

In summer 2015, he returned to Olympia to finalize his 3-D models and is publishing his findings, which should help inform the debate. A long-term goal is to make the models available via an interactive website through UNL's Center for Digital Research in the Humanities.



Protecting Nanoparticles Carrying Therapeutic Drugs

The liver and spleen have been thwarting researchers' attempts to deliver a nanoparticle carrying therapeutic drugs to its target. A UNL team has discovered that citric acid is the key ingredient in armoring the nanoparticle against the organs' molecule chomping.

Nanoscale drug delivery techniques are potentially safer and more effective methods of administering drugs than conventional treatments.

One method of slipping synthetic drugs past the body's immune defenses is to use a Trojan horse, enveloping the drug in a nanomaterial made from zein, a corn protein that appears nonthreatening. Zein is widely used in the food, paper and other industries.

But that friendly exterior also makes it susceptible to the liver and spleen, which break down proteins and other biological products.

The UNL team learned that citric acid acts as a kind of mortar to bind the nanoparticle's protein molecules together more tightly, creating a much more durable structure. They've shown that zein nanoparticles fortified with citric acid successfully delivered the cancer drug 5-Fluorouracil to the kidneys in mice.

Importantly, citric acid is nontoxic, said project leader Yiqi Yang, Charles Bessey Professor in textiles, merchandising and fashion design and biological systems engineering. Other successful strengtheners are carcinogenic, limiting their medical usefulness.

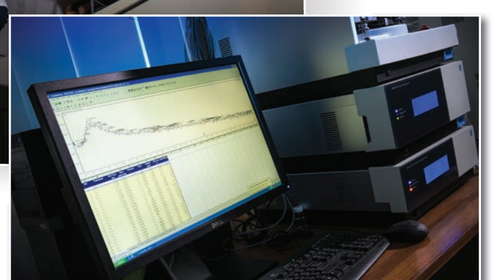
The reinforced structure also has potential for use in regenerating human tissue, he added.

Earlier, Yang and his colleagues improved the zein nanoparticle's functionality as a drug delivery system by creating a hollow center that increases its loading capacity.

Yang said he hopes to work with an industry partner to develop the enhanced zein nanoparticles for use in delivering targeted drug therapies.

He was prompted to work on zein because the protein is a ubiquitous byproduct of the corn industry.

"In Nebraska, we have a lot of corn protein left after utilization of corn starch," Yang said. "Our initial motivation was to figure out a way to add value to our agricultural industry."



Top: Yiqi Yang and research assistant professor Helan Xu
Above: Calibration curves show protein cross-linking reactions with polycarboxylic acids.

3-D Model Helps Manage Bridge Repairs

Checking bridges for structural safety is imperative, but every inspection generates a colossal amount of complex data. Pinpointing which parts most urgently need repair is difficult.

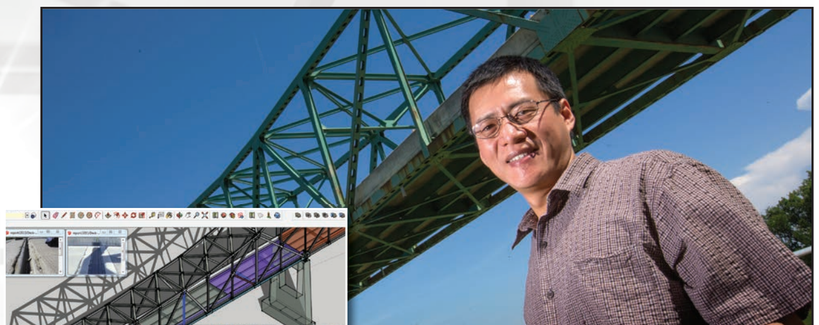
To solve this "big data" challenge, a UNL team created a visually based 3-D data management tool that helps officials more easily monitor deteriorating bridges and prioritize repairs.

"A typical steel bridge has hundreds of thousands of elements. That's humongous amounts of data. The elements all have a spatial relationship to each other, but the current data system doesn't reflect that relationship," said project leader Zhigang Shen, an associate professor in the Charles W. Durham School of Architectural Engineering and Construction at the Peter Kiewit Institute in Omaha.

Their tool creates a 3-D model of a bridge. With a mouse click, engineers can identify which parts require fixing.

The model color codes each component based on condition, from good-to-go green to urgent red. Clicking on a component brings up inspection reports as well as photos of cracks, corrosion or other damage.

Engineers can compare data and photos from several years to understand the rate of deterioration and better plan repairs.



More than 61,000 of the nation's bridges are structurally deficient, according to the U.S. Department of Transportation. It would cost an estimated $115 billion to repair all these deficiencies.

When completed in late 2015, the tool should help cash-strapped municipalities prioritize bridge repairs, Shen said. He already has received lots of national and international inquiries and is considering starting a company to commercialize the tool.

Above: Zhigang Shen at Omaha's Mormon Bridge
Left: Data management tool showing Mormon Bridge

He hopes to continue adding features like sensors to monitor bridge conditions in real time and to better understand what causes deterioration, such as weather conditions.

The Nebraska Department of Roads funds this project. State bridge engineer Mark J. Traynowicz said he thinks roads officials nationwide would find the system useful.

"It's a good product to see how our bridges are aging and how they're holding up," Traynowicz said.

Ronnie Green

Timothy Wei

Investments Target Strengths

Through strategic investments in faculty and infrastructure, UNL is building its research capacity to tackle critical challenges and opportunities facing Nebraska and the world.

UNL is in the midst of initiatives to hire faculty who expand the university's expertise in high-impact areas and to enhance research infrastructure supporting these areas. Strategic recruiting efforts are underway in the Institute of Agriculture and Natural Resources and the College of Engineering and in the works in other colleges.

"We want to be known as the best in the world in key areas. These investments are going to pay off for us in the long term," said Ronnie Green, Harlan Vice Chancellor of IANR and UNL's interim senior vice chancellor for academic affairs.

IANR has expanded its faculty by 14 percent with 38 new faculty positions since 2012 and is recruiting 34 more.

The numbers are impressive, Green said, but the hiring strategy makes the difference. The institute takes a holistic approach, recruiting people to work across disciplines to solve critical problems for the future instead of hiring by departments.

IANR's hires focus on critical areas related to food production, fuel and water resources issues because that's where UNL can have the greatest impact, he said.

College of Engineering Dean Timothy Wei and colleagues embarked on a similar process, targeting food manufacturing, civil infrastructure, national defense and biomedical engineering. Engineering is hiring 100 new faculty, half for newly created positions, with expertise that cuts across focus areas. So far 32 new faculty have joined the college.

"We want to be known as the best in the world in key areas. These investments are going to pay off for us in the long term."

"We're recruiting for a special brand of person who sees how their expertise connects in interesting and interdisciplinary ways," Wei said.

The college also hosts national and global conferences to help articulate problems, encourage partnerships and establish UNL as a thought leader in these key areas.

New infrastructure supports faculty and research. UNL has invested in new laboratory facilities, greenhouses and research centers on campus, at Nebraska Innovation Campus and throughout the state.

Green and Wei say these investments are already paying off, increasing UNL's competitiveness for major grants, enticing graduate students and leading to new public- and private-sector collaborations.

"The bottom line is we're going to be able to do a lot more, a lot faster, with bigger impact," Green said.

Fueling Global Collaborations

Joe Francisco definitely wants the College of Arts and Sciences to think globally.

In his first year as dean, UNL's largest college launched initiatives to fuel research collaborations on regional and global issues and to strengthen academic diversity.

"It's a global environment," Francisco said. "I strongly believe the college has to connect and engage within the global context. That means we have to foster a diverse academic community."

To help faculty reach the world stage, the college offers grants for international conferences. Faculty showcase their research and bring new ideas and potential partnerships to their research and teaching.

Physicist Aaron Dominguez, named associate dean for research in 2014, uses his expertise in international collaborations to encourage faculty to work globally. Dominguez and other UNL high energy physicists work on the international Large Hadron Collider project at CERN in Switzerland. He leads a U.S. research partnership to upgrade one of the particle detectors.

The college encourages research collaborations by funding faculty and students to visit or host research partners. For promising global collaborations, it is exploring ways to create more enduring links through formal research agreements and student exchanges.

Joe Francisco

"Building those partnerships from the ground up encourages, incentivizes and strengthens those global research collaborations," Francisco said.

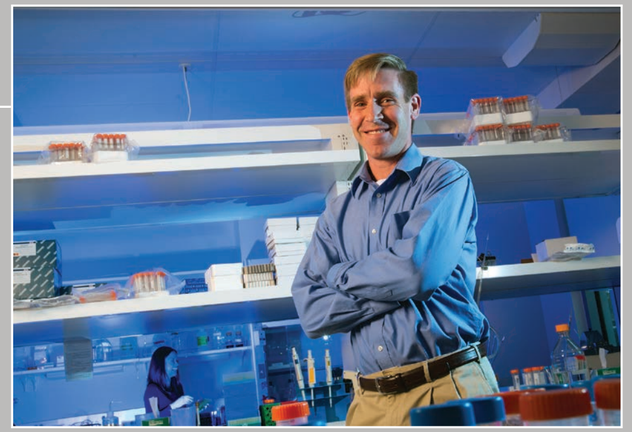
Efforts to cultivate collaborations throughout the college and with other UNL departments have encouraged faculty from disparate fields to team on large and small multidisciplinary projects.

One project brings together climate scientists, political scientists and law faculty – disciplines that haven't traditionally worked together – to better inform both scientific research and policies regarding climate change.

Another new project explores immigration in the Great Plains region. Faculty in the social sciences, psychology, ethnic studies, modern languages, history and other departments are studying the multifaceted implications of rapid demographic change in rural and urban areas.

"We took opportunities to think broadly, collaboratively and in an engaging way to invest in new directions that build on the college's strengths," Francisco said.

Research Highlights



Understanding Immunity

Understanding how a poxvirus evades human defenses may lead to better treating some viral diseases, including HIV and herpes. With $1.8 million from the National Institutes of Health's Institute of Allergies and Infectious Diseases, UNL virologist Matthew Wiebe studies how the poxvirus vaccinia disables BAF, a key human defense protein. BAF seems to bind to viral DNA, preventing it from replicating. Understanding how the vaccinia virus controls BAF provides clues about how the protein works. That could lead to treatments for viruses, such as HIV, that attack by injecting viral DNA into cells. Wiebe's research is part of a scientific effort to understand how human immunity defends against foreign DNA, while protecting the body's DNA. Wiebe, of the School of Veterinary Medicine and Biomedical Sciences, is a member of the Nebraska Center for Virology.

Trenton Franz with cosmic-ray neutron rover

Tracking Soil Moisture from Cornfields to Battlefields

Despite the sci-fi name, a cosmic-ray neutron rover has the down-to-earth job of traversing farm fields to measure soil moisture. UNL hydrogeophysicist Trenton Franz helped develop this tool for precision agriculture. He's adapting it to help the U.S. military quickly and reliably survey, monitor and map soils. The rover, a truck mounted with sensors, measures subatomic neutron particles in the air to reliably estimate water in soil. Currently, measuring soil moisture is largely restricted to small and large spatial scales. This tool fills the critical gap between the two. Soldiers moving heavy machinery could make soil maps on the fly to help them better identify muddy conditions and predict transport times. The U.S. Army's Cold Regions Research and Engineering Laboratory funds this research. Franz also is using his technology to measure soil moisture in an endangered South African forest. He's collaborating on a National Science Foundation-funded project assessing environmental impacts of commercial groundwater pumping near Mapungubwe National Park.

Viewing Architecture as Impermanent

UNL architecture professor Rumiko Handa has written a new book urging architects to consider wear and change in a building's life and incorporate anticipated adaptations into their designs. *Allure of the Incomplete, Imperfect and Impermanent: Designing and Appreciating Architecture as Nature,* published by Routledge, argues that a building is not complete once construction has finished. Its life begins when people move in, requirements change and materials deteriorate. This view runs contrary to the established ideal that architectural pieces remain permanently perfect. "I'm finding beauty in the things that are not necessarily perfect. A building is not just insufficient or old and irrelevant," Handa said. "Of course, not all imperfect things are beautiful, but I think we need to somehow cultivate our eyes to include these values."

New Home for College of Business Administration Going Up

A new home for UNL's College of Business Administration is taking shape on campus. Construction is underway on the $84 million, 240,000-square-foot structure, the largest academic building project in recent UNL history. Located in the heart of City Campus at 14th and Vine streets, it is slated to open in fall 2017. The new building will include interactive learning in state-of-the-art classrooms, one-stop student support services and a space to host events. It is funded exclusively from private donations from CBA alumni and business partners. "This building is truly being built by our alumni for future alumni," said CBA dean Donde Plowman. To accommodate its growing enrollment, CBA added 36 faculty in the past four years and were recruiting another 20 in 2015.

Digitizing Pueblo Archaeological Records

The excavation records of an ancient pueblo civilization soon will be publicly available, thanks to UNL anthropologist Carrie Heitman and a multi-institutional effort. With a $300,000 National Endowment for the Humanities grant, researchers are digitizing about 1.5 million photographs, field notes and other records generated during 1970s and 1980s excavations of the 1,000-year-old Salmon Pueblo in northwestern New Mexico. A remote outpost of the Chaco Canyon cultural hub of ancient pueblo people, Salmon Pueblo is known for its 300-room "great house." The Chaco Research Archive, which Heitman directs, will house the digitized records. Digital access will allow researchers to explore more fully this historically and culturally significant community. Collaborators are the Salmon Ruins Museum, Archaeology Southwest, UNL's Center for Digital Research in the Humanities and the University of Virginia's Institute for Advanced Technology in the Humanities, home to the Chaco Research Archive.

Research Highlights

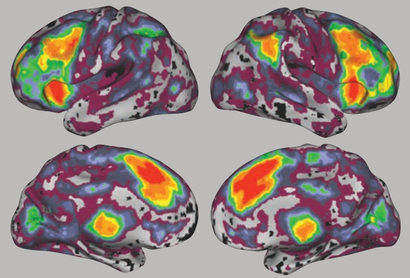
Tiny Surgical Robots Could Be Lifesavers

Miniature, remotely controlled robots could bring lifesaving surgical expertise to remote or dangerous spots, such as battlefields. With $2.8 million from the U.S. Army Medical Research Acquisition Activity, UNL and University of Nebraska Medical Center researchers continue their collaboration to develop miniaturized surgical robots. UNL's share is $687,000. The team, co-led by Shane Farritor, Lederer Professor of Engineering, and UNMC's Dmitry Oleynikov, previously received $1.4 million for the project. The robots could enable a battlefield surgeon to perform complex, lifesaving surgery aided by another surgeon thousands of miles away. The mini-robot would be inserted inside the patient. Controlled remotely, it would transmit live video so surgeons could diagnose the trauma and serve as remote first responders. These tiny robots also could aid surgery in civilian settings.

Shane Farritor (left) and Dmitry Oleynikov (seated) test a new robotic device.

Brain's Response to Errors of its Ways

Everyone makes mistakes, but how does the brain respond to errors? A team led by Maital Neta, a UNL psychologist and researcher in UNL's Center for Brain, Biology and Behavior, found that even basic errors trigger neural activity across a much broader swath of the brain than previously thought. Functional MRI scans of study participants as they completed 12 tasks found substantial differences in activity in 41 brain regions following incorrect versus correct answers for most tasks. Neuroscientists previously believed only one region responded to errors. The study's information can be used to investigate specific linkages between regions and error-related reactions. The study appeared in the *Journal of Neuroscience.* Washington University in St. Louis and the Center of Excellence for Research on Returning War Veterans in Waco, Texas, contributed to this research.



Team IDs Four New Tuco-tuco Species

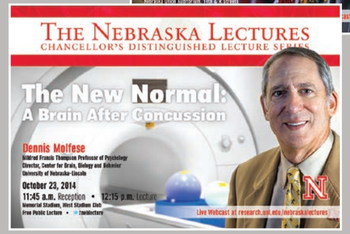
A UNL-led research team identified four new species of tuco-tuco, a burrowing gopher-like rodent found throughout much of South America. Identifying new mammal species is rare, said team leader Scott Gardner, director of the H.W. Manter Laboratory of Parasitology and a University of Nebraska State Museum curator. The discovery demonstrates the broad range of biological diversity in Bolivia, where the new species from the genus *Ctenomys* were found. Three live on geographically isolated high ridges, which fostered the evolution of distinct species. A fourth was found in the eastern lowlands. The Museum of Southwestern Biology at the University of New Mexico and New York's American Museum of Natural History collaborated on this project.

Whitman Poem Discovery

Digging through historic newspapers at the Library of Congress, UNL art historian Wendy Katz discovered a new poem by Walt Whitman. She found the poem in the June 23, 1842, issue of *New Era* while researching art criticism as a Smithsonian Senior Fellow in Washington, D.C. The poem, "To Bryant, the Poet of Nature," addresses William Cullen Bryant, an American romantic poet and *New York Evening Post* editor. Katz's attribution centers on three arguments: the poem's accreditation to "W.W.," Whitman's poetics before and after writing his famous "Leaves of Grass" poetry collection and his relationship with editors of political presses during that time. Katz's discovery was published in the *Walt Whitman Quarterly Review*.

Nebraska Lectures

Unraveling the mystery of the "God particle" and studying brain behavior were timely topics in the 2014-2015 Nebraska Lectures: Chancellor's Distinguished Lecture Series. Dennis Molfese, Mildred Francis Thompson Professor of Psychology, presented "The New Normal: A Brain After Concussion." In his fall lecture, Molfese explained how researchers in UNL's Center for Brain, Biology and Behavior are investigating the long-term effects of concussion on athletes' cognitive, emotional and behavioral functions, a growing concern in athletics at all levels. Dan Claes, professor and chair of physics and astronomy, presented "What the Heck is a Higgs boson?" at the spring lecture. Claes discussed the Higgs boson's significance in understanding matter, how UNL researchers contributed to its discovery and UNL's ongoing work on international research at CERN's Large Hadron Collider in Switzerland. The Office of the Chancellor, Research Council and the Office of Research and Economic Development, in collaboration with the Osher Lifelong Learning Institute, co-sponsor these lectures featuring prominent faculty.



Research Highlights

Molecular Mechanisms of Disease Program Expands

Whether metastasizing as cancer, progressing as Alzheimer's or spreading as HIV, nearly all human disease originates from molecular interactions occurring throughout the body. With support of a five-year, $1.1 million grant from the National Institutes of Health, a UNL training program is expanding efforts to combat and treat diseases by preparing more doctoral students for careers spent researching their molecular catalysts. Launched as a pilot program in 2013, the Molecular Mechanisms of Disease program taps expertise of 28 faculty mentors in seven departments. The National Institute of General Medical Sciences funding allows the program to add 30 doctoral trainees over the next five years. Nebraska is the first among nine neighboring states to offer an NIH-funded training program in the cellular, biochemical and molecular sciences, said founding director Melanie Simpson, Susan J. Rosowski Professor of Biochemistry.

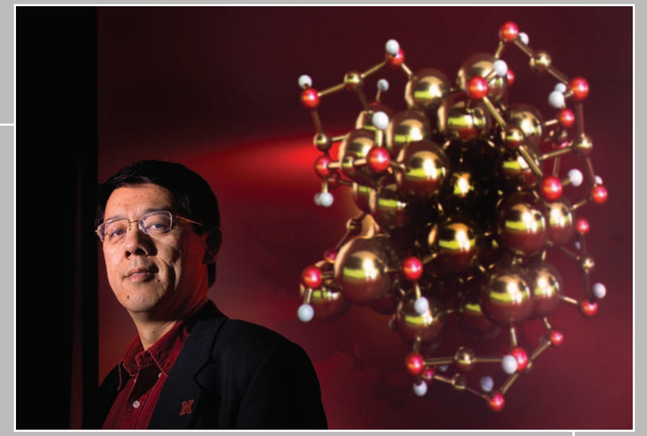
Melanie Simpson (left) and doctoral student Abby Gelb

Charlton Named Associate Vice Chancellor for Research

William Charlton is a new UNL associate vice chancellor for research and professor of mechanical and materials engineering. Charlton came to Nebraska in June 2015 and divides his time between UNL and the University of Nebraska's National Strategic Research Institute, where he is research director for nuclear programs. As associate vice chancellor, Charlton works with UNL faculty and sponsors on defense-related research. An expert in nuclear nonproliferation research and education, Charlton joined Nebraska from Texas A&M University, where he was the founding director of the Nuclear Security Science & Policy Institute since 2006 and a nuclear engineering faculty member since 2003. He has been a consultant and technical staff member in the Nonproliferation and International Security Division at Los Alamos National Laboratory. He continues to work closely with several national laboratories. Charlton holds doctorate, master's and bachelor's degrees in nuclear engineering from Texas A&M.

Telling Refugees' Stories

Providing a valuable news resource for a diverse refugee population is the aim of Nebraska Mosaic, a capstone course in UNL's College of Journalism and Mass Communications. The community news project gives student journalists a chance to hone their international reporting skills by developing stories, photos and videos covering refugees navigating their new lives in Lincoln, Nebraska, a federally designated resettlement community. Their work is published online at http://cojmc.unl.edu/mosaic/ and through social media. Nebraska Mosaic is the outgrowth of a 2010 New Voices grant from the J-Lab at American University. Tim Anderson, associate professor of practice in news-editorial, is project adviser.



Modeling New Atomic Structures of Gold Nanoparticles

Gold nanoparticles hold promise for their potential to remove air pollutants and deliver drug therapies, among other applications. UNL's Xiao Cheng Zeng, Ameritas University Professor of Chemistry, and colleagues revealed four atomic arrangements of a gold nanoparticle cluster that appear more stable than previously reported configurations. The team modeled the configurations using computational analysis through the university's Holland Computing Center, a nontraditional approach to atomic structure analysis. Identifying the nanoparticle's most stable configurations could allow researchers to improve its use in drug delivery to treat cancers and other diseases and as a catalyst in neutralizing carbon monoxide vehicle emissions. Zeng's team reported its findings in *Science Advances*. The Shanghai Institute of Applied Physics collaborated on this project, which was funded by the U.S. Army Research Laboratory and the Nebraska Center for Energy Sciences Research.

Bloom Expands U.S. CMS Leadership Role

As experiments at CERN's Large Hadron Collider restarted in spring 2015, UNL physicist Ken Bloom focused on U.S. contributions to the worldwide computing grid that captures the massive data from this research. He was named software and computing manager for the U.S. Compact Muon Solenoid operations program in 2015. The CMS is one of two particle detectors for the LHC in Switzerland. Bloom and UNL's particle physics team collaborate with scientists worldwide on LHC research that led to discovery of the Higgs boson. U.S. CMS operations coordinates U.S. support for the CMS detector and its software and computing infrastructure. Previously Bloom led the U.S. CMS Tier 2 program and was deputy manager of software and computing. In his current role, he oversees an annual budget of $18 million, which supports staff and funds computing hardware at the Department of Energy's Fermilab in Illinois, as well as seven Tier 2 computing sites at universities nationwide, including UNL, that store and share data used by physicists worldwide.

Weller Named Museum Director

Susan J. Weller is the new director of the University of Nebraska State Museum of Natural History and professor of entomology at UNL. She joined Nebraska in October from the University of Minnesota where she was executive director and curator of invertebrates at the Bell Museum of Natural History and professor of entomology. Active in scientific and museum organizations, Weller is vice president-elect of the Entomological Society of America and will be president in 2017. She earned her bachelor's degree in biology from Grinnell College and her doctorate in zoology from the University of Texas. At UNL, Weller will lead Nebraska's premier natural history museum, which has more than 5 million specimens in its research collections and a statewide mission of research, education and public outreach. The museum is accredited by the American Alliance of Museums and is a Smithsonian Affiliate Museum. She succeeds Priscilla Grew, who retired after 12 years as museum director.

Research Highlights

UNL Research Fair

The biannual UNL Research Fair provided opportunities to explore university research priorities, hear from federal experts and celebrate faculty and student successes. The fall 2014 event featured a faculty retreat on digital creativity and interdisciplinary collaborations with the Johnny Carson School of Theatre and Film. It included presentations on defense funding opportunities, increasing participation in STEM disciplines, mentoring for postdocs and a celebration of the Center for Children, Youth, Families and Schools' 10th anniversary. Featured presenters included Barry Pallotta, Defense Advanced Research Projects Agency; Cindy Daniell, SRI International; N. Radhakrishnan, consultant; Thomas W. Brock, National Center for Education Research; and Ellen McCallie, National Science Foundation. The spring 2015 event featured poster sessions that showcased research and creative accomplishments by UNL graduate and undergraduate students.

Improving Low-moisture Food Safety

Nuts, spices, peanut butter and other low-moisture foods, long considered safe, can contain enough harmful bacteria to sicken people. Current pasteurization methods that kill pathogens are time-consuming and frequently harm quality of dry foods. A UNL food science and engineering team received nearly $950,000 to develop and implement technologies that eliminate pathogens and protect food quality. This research is part of a $5 million U.S. Department of Agriculture initiative to enhance low-moisture food safety. The team will share findings with food processors and work with them to meet new food safety regulations. Collaborators are Michigan State University, Washington State University, Illinois Institute of Technology and North Carolina State University.

Driver's Ed Reduces Teen Crashes, Tickets

Driver's education significantly reduces crashes and traffic violations among new drivers, according to a UNL study of nearly 152,000 Nebraska teen drivers over eight years. Young drivers who have not completed driver's education are 75 percent more likely to get a traffic ticket, 24 percent more likely to be involved in a fatal or injury accident and 16 percent more likely to have an accident, the study showed. Findings by educational psychologists Duane Shell and Ian Newman of UNL's Nebraska Prevention Center for Alcohol and Drug Abuse challenge more than three decades of assumptions about the value of driver's education. The study appeared in *Accident Analysis and Prevention.*

Sending Drones into Storms for Science

Flying drones into storms is giving researchers new insights about severe weather. To stay on the forefront of this burgeoning research area, UNL and University of Colorado Boulder colleagues founded the Unmanned Aircraft System and Severe Storms Research Group. This consortium provides a structured working relationship among an expanding number of research partners. It's an outgrowth of ongoing research by UNL atmospheric scientist Adam Houston and University of Colorado colleagues. The CU-UNL team's research with drones has yielded several firsts, including the first direct sampling of a thunderstorm system by a drone and the first simultaneous samplings of thunderstorm outflow by multiple drones. Consortium collaborators from universities, federal laboratories, the private sector and other institutions work to advance the use of drones in severe storms research.

Accolades

- **John Woollam,** George Holmes University Professor of Electrical Engineering, was named a Fellow of the National Academy of Inventors. Woollam, an internationally known expert in ellipsometry and a UNL faculty member since 1979, also is founder and president of the J.A. Woollam Co. A university spinoff, Woollam's company is a worldwide leader in the production of spectroscopic ellipsometry instrumentation. The company manufactures ellipsometers for a wide range of applications and, with distributorships in more than a dozen countries, has sold over 2,500 ellipsometers worldwide. Woollam is named on 57 patents and his company has secured more than 100 patents.

- **Waskar Ari,** associate professor of history and ethnic studies, received a fellowship from the American Council of Learned Societies for the fall 2015 semester. During his fellowship, he is focusing on his research project, Women's Strategies of Autonomy: Segregation, Sexuality, and Agrarian Reforms in Bolivia, 1870-1964.

- *The Counter-Cinema of the Berlin School,* authored by **Marco Abel,** associate professor of English and film studies, won the German Studies Association's 2014 Book Prize, which recognizes the best book in the fields of German language literature and Germanistik, or culture studies. The book examines the political role of a new wave of filmmakers in Germany and argues that the Berlin School films comprise a counter-cinema that depicts a German people that has not yet come to be.

- **Stephen Taylor,** professor of food science and technology, received the Institute of Food Technologists' 2015 Nicholas Appert Award. This achievement award recognizes preeminence in and contributions to food technology. Taylor was honored for his comprehensive investigative work on food allergens.

- Two UNL biological systems engineers won prestigious Gold Medal awards from the American Society of Agricultural Engineers in 2014. **Suat Irmak,** Harold W. Eberhard Professor of Biological Systems Engineering, received the John Deere Gold Medal Award for global leadership and contributions to improved understanding of soil, water and plant relationships through advances in evapotranspiration modeling and environmental biophysics. Irmak also received the Heermann Sprinkler Award for work that leads to more efficient, effective sprinkler irrigation. **David Jones,** professor of biological systems engineering, won the 2014 Massey-Ferguson Educational Gold Medal Award for contributions to development and delivery of biological systems engineering education.

- **Stephen Burnett,** professor of classics and religious studies, earned a fellowship at the Institute for Advanced Study in Princeton, New Jersey, for the 2015-2016 academic year. He is conducting research for a book about Martin Luther and is part of a group of about 30 humanities scholars in the institute's School of Historical Studies. Burnett also received a Humboldt Research Award from Germany's Alexander von Humboldt Foundation. The award, which recognizes researchers whose work has significant impact and who are expected to continue cutting-edge work, will allow Burnett to conduct research for his book in Germany.

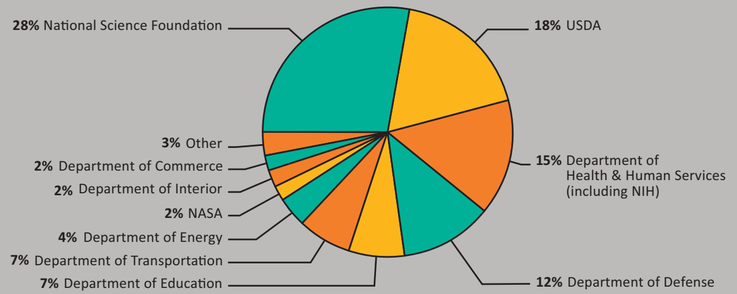
- **Jim Lewis,** Aaron Douglas Professor of Mathematics and director of UNL's Center for Science, Mathematics and Computer Education, earned the Mathematical Association of America's Gung and Hu Award for Distinguished Service to Mathematics, which honors extraordinary contributions that have shaped mathematics and mathematical education nationally. He also received the American Mathematical Society's 2015 Award for Impact on the Teaching and Learning of Mathematics, the organization's highest award for service.

Financials

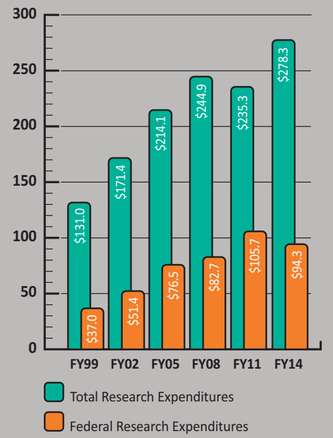
Research Expenditures

UNL's research expenditures totaled more than $278 million in 2014, the most recent fiscal year for which expenditure information is available. This total included more than $94 million in federal research expenditures. The National Science Foundation accounted for 28 percent, followed by 18 percent from the U.S. Department of Agriculture, 15 percent from the Department of Health and Human Services (including the National Institutes of Health) and 12 percent from the Department of Defense. UNL's goal is to achieve $300 million in research expenditures by 2018, with at least half coming from federal agencies.

FY 2014 Research Expenditures by Federal Agency



Total Research Expenditures
(in millions)



Credits

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