

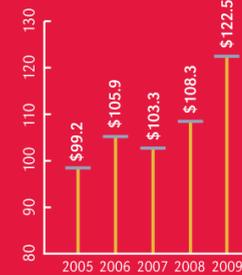


Financials

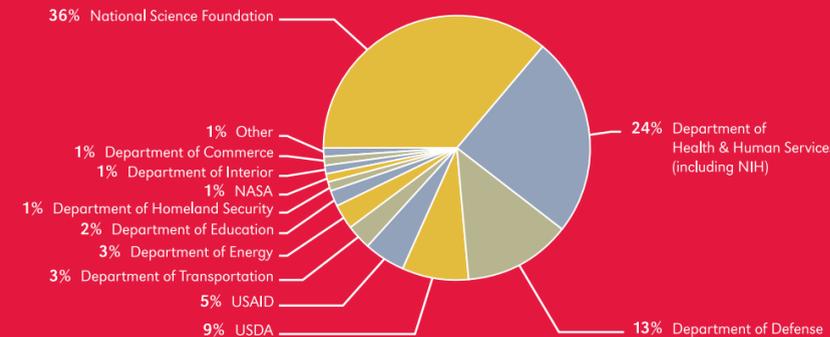
Record Research Funding

UNL faculty earned a record \$122.5 million in research funding during the fiscal year that ended June 30, 2009. Funding increased 13 percent from \$108.3 million a year earlier. Of the total research funding in FY 2009, nearly \$84 million was awarded by the federal agencies shown in the chart below. Total external funding for sponsored programs, which includes research and other activities, also set a record of \$192.3 million, up from \$176.6 million in the previous fiscal year.

Five-Year Total Research Funding (in millions)



FY 2009 Research Funding by Federal Agency



Five-Year Total Sponsored Programs Funding (in millions)

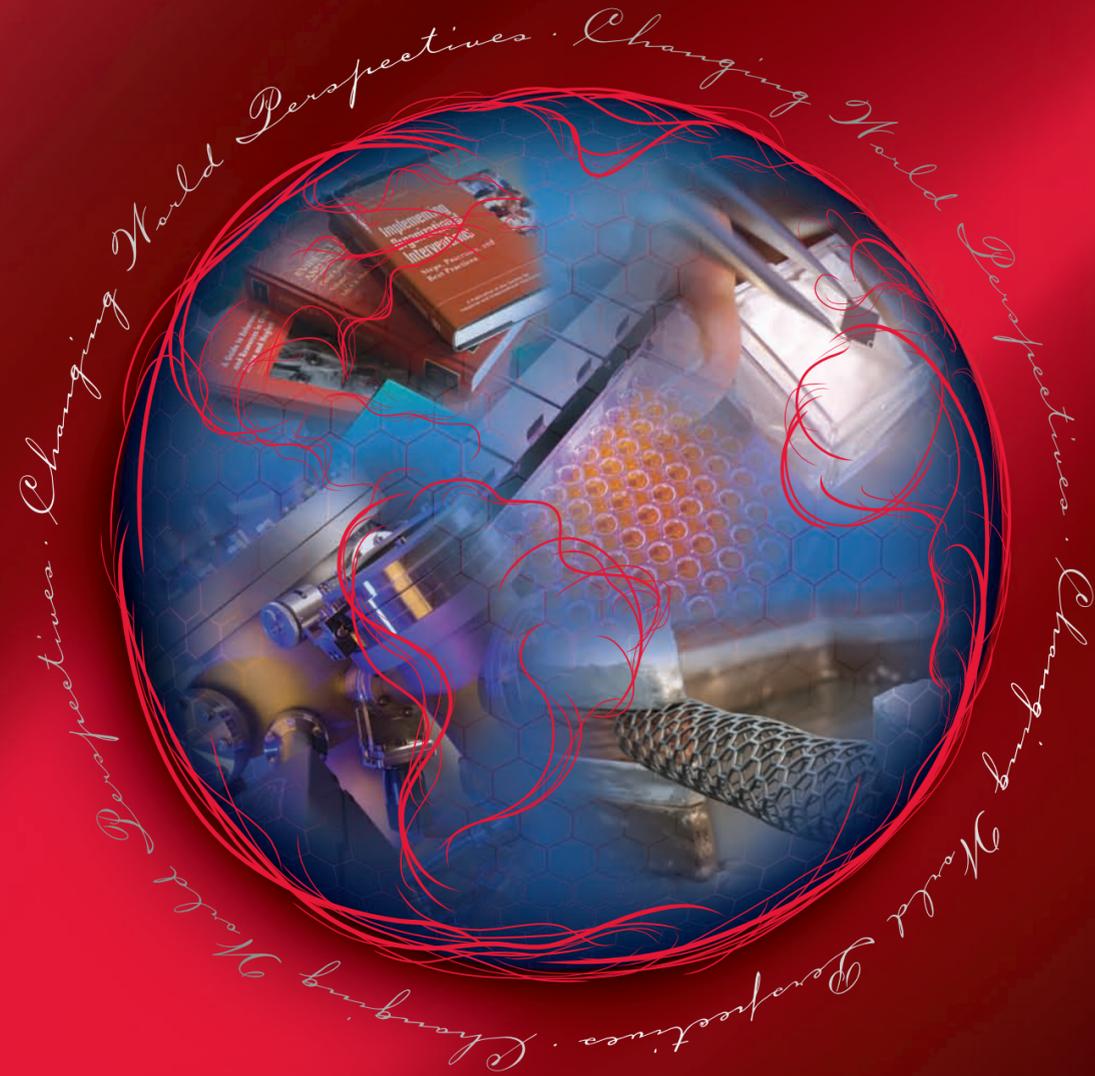




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On the Cover

These images reflect the diversity and global reach of research at the University of Nebraska–Lincoln. From discoveries in nanoscience, nutrigenomics and software engineering to innovative initiatives in math achievement, child welfare, water and climate change, UNL faculty are engaged in meeting the challenges of a changing world.

New Perspectives

Today, more than ever, change is global. The complex challenges we face in water, food, energy, climate and other areas are worldwide concerns that demand new perspectives and partnerships.

At the University of Nebraska–Lincoln, our research enterprise has grown significantly, and we're building on our successes. We're achieving record funding and establishing leadership in emerging research areas, from nutrigenomics to the systems biology of social behavior. This annual report highlights some of these successes.

We're harnessing this momentum to advance new initiatives with an innovative perspective on research that responds to our changing world. We are reaching beyond our institutional, state and national borders to build partnerships that seek solutions to global challenges and enhance our state's economy.

The University of Nebraska is establishing a Global Water for Food Institute to bring an international, multidisciplinary research approach to one of the most urgent questions facing our world:

How can we grow more food with less water? This challenge requires not only the best minds in science and engineering, but the most creative thinkers in policy, law and human behavior. UNL's National Science Foundation-funded IGERT program also exemplifies this approach. It brings together students and faculty from the natural, social and computer sciences and law, and U.S. and European partners, to study new ways to manage stressed watersheds.

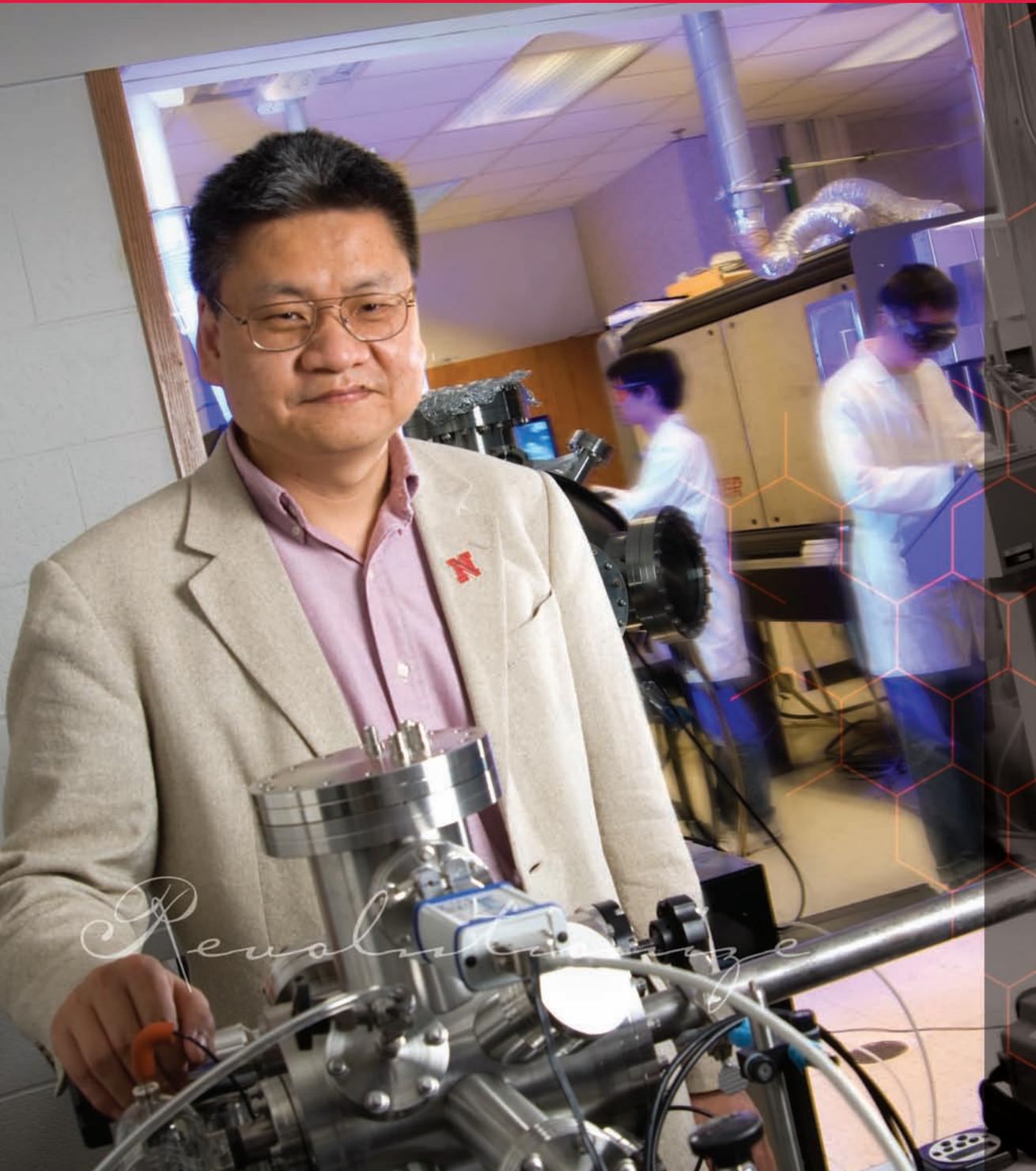
This new perspective requires building productive partnerships with federal agencies, private enterprise, foundations and others. Partnerships are at the root of UNL's Nebraska Innovation Campus, the private-public research campus being developed at our university. It will provide a collaborative, synergistic environment for developing novel ideas, tools and technologies that solve problems and create economic opportunities for our state.

I invite you to read this report and imagine the far-reaching solutions that innovative, collaborative research can bring to complex global challenges that lie before us.

Prem S. Paul
Vice Chancellor for Research
and Economic Development

Chancellor Harvey Perlman (left) and
Vice Chancellor Prem Paul





“This process can dramatically improve the cost-effectiveness and productivity of using carbon nanotubes as basic building blocks for fabricating devices and structures.”

Yongfeng Lu

Self-aligning Nanotubes

Carbon nanotubes, with their unique electrical properties, have long held promise for revolutionizing electronics and optics. But finding ways to make these cylindrical structures that are 10,000 times thinner than a human hair cheaply and precisely enough for commercial use is a daunting challenge.



Illustration of self-aligning carbon nanotube production

A team led by Yongfeng Lu, an electrical engineering professor at UNL, has taken a giant step forward.

To date, carbon nanotubes are grown using a method called chemical vapor deposition. The process can produce millions of nanotubes at a time, but lacks precision and alignment control, which limits its use in precise applications. Researchers need a simple technique for manipulating nanotubes so they align in useful ways.

With funding from the National Science Foundation, Lu and colleagues in UNL’s Laser Assisted Nano-Engineering Lab discovered

a method that produces precisely aligned nanotubes in a single step. Lu’s team heats small areas of electrodes by focusing a laser to concentrate light on regions much smaller than light wavelengths. The one-step process makes multiple carbon nanotubes at a time, each one self-aligned and exact.

There’s no need for expensive instrumentation or complex processes to manipulate carbon nanotubes after growth.

“Therefore, they can be easily integrated into devices and circuits,” said Lu. “This process can dramatically improve the cost-effectiveness and productivity of using carbon nanotubes as basic building blocks for fabricating devices and structures.”

Lu hopes to scale up the process to produce large numbers of self-aligned nanotubes, which could lead to their use in new applications such as biosensors, tiny molecular motors or memory cells. NUtech Ventures, formerly UNL’s Office of Technology Development, is exploring commercialization options.

For Lu, a leader in laser-based materials research, the new technique is one of many innovations in nanoscale laser-material

interactions and microprocessing technologies. Lu envisions using his research on laser-based technologies to one day mass produce nanodevices and circuits using carbon nanotube structures. This pioneering carbon nanotube technique moves Lu a step closer to that goal.



Harnessing Nanotechnology's Potential

From medicine and electronics to energy and the environment, nanotechnology promises to change our world. Researchers at UNL's Materials Research Science and Engineering Center (MRSEC) are exploring how to harness this nanopower.

More than 20 UNL physicists, chemists and engineers collaborate to study new magnetic structures and materials as small as one-billionth of a meter. Understanding the properties and performance of nanomaterials is a key step toward using them to create advanced technologies, said physicist Evgeny Tsybmal, MRSEC's director.

For example, physicist Christian Binek studies magnetism for use in spintronics, which exploits the spin of electrons in addition to their conventional electrical charge. This could lead to exponentially smaller, faster and more powerful computers and electronic devices.

Multidisciplinary collaboration is essential, Binek said. "We are combining materials that don't happen in nature, which might be causing a chemical reaction that produces unwanted results. For a

chemist that may seem obvious, but for a physicist, if we aren't talking, it may be a painful learning curve."

MRSEC researchers share equipment as well as expertise. For his research, physicist Axel Enders built an ultrahigh-vacuum chamber to exclude oxygen when creating nanomaterials and a unique low-temperature scanning tunneling microscope that makes atoms of nanostructures visible. Both aid broader MRSEC research.

"Collaborating with others is very inspiring. Now, we can do things that any one of us could not do alone. MRSEC is one of the reasons I came to UNL," said Enders, who recently won a prestigious National Science Foundation CAREER award.

Established in 2002 with a \$5.4 million NSF grant, MRSEC received an \$8.1 million, five-year renewal grant in 2008. Its research, which focuses on quantum and spin phenomena in nanomagnetic structures, has garnered international attention.

MRSEC's research has potential applications in advanced computing, data storage, energy production, handheld electronic devices, sensors and medical technologies. The center also has a strong education and outreach program and collaborates with industry, national laboratories and scientists internationally.

"Our long-term goal is to be the leading interdisciplinary center for integrated research and education in nanomagnetism," Tsybmal said.



Axel Enders



Above: Christian Binek (left) with graduate students Yi Wang and Srinivas Polisetty

Grad Program Wades into Water Issues

In our increasingly thirsty world, managing water is complex and important. A new interdisciplinary graduate education program at UNL is preparing future scientists, policymakers and natural resource managers to tackle global water issues.

A \$3.1 million, five-year grant from the National Science Foundation's Integrative Graduate Education and Research Traineeship Program (IGERT) funds the program, "Resilience and Adaptive Governance in Stressed Watersheds." It integrates the scientific, socio-economic and legal aspects involved in studying and

managing complex systems of people and nature. Doctoral students from natural, computer and social sciences disciplines will study stressed watersheds in the U.S. and Eastern Europe, testing their training with real-world experiences.

"Resolving increasingly complex water issues requires the best and clearest scientific information from interdisciplinary and integrative science, and the best well-trained scientists we can provide," said wildlife ecologist Craig Allen, who leads UNL's multidisciplinary IGERT program.



Craig Allen

Over the next five years, 26 doctoral trainees will explore every aspect of managing stressed watersheds, starting with Nebraska's Platte River. Research focuses on understanding and enhancing the resilience of over-appropriated watersheds in the Great Plains, where agricultural production and critical habitats rely on fluctuating water resources. Students also will study watersheds in Poland and Hungary in cooperation with the program's international partner, the International Institute of Applied Systems Analysis in Austria.

About 20 UNL faculty in natural, social and computer sciences and law helped develop the curriculum and will work with graduate students. Local, state and federal organizations, some of which are formal partners in UNL's program, will help shape an interdisciplinary curriculum and research externships or practice-based learning.

"The program will help fundamentally change academic culture by coalescing students, faculty and partners from many scientific disciplines around a common goal of sustainably managing over-appropriated watersheds," Allen said.

Water for Food: A Global Challenge

In a time of rapid population growth, increasing demand for limited water supplies and unknown risks of climate change, producing more food with less water is one of the greatest global challenges.



Jeff Raikes



The conference laid the groundwork for a Global Water for Food Institute being established by NU and located at UNL. This research institute will be dedicated to helping the world efficiently use its limited water resources to ensure the food supply for current and future generations. Participants discussed how the institute can develop innovative science, technology and tools to meet this challenge. The conference proceedings will be available online in fall 2009 at waterforfood.nebraska.edu.

The Robert B. Daugherty Charitable Foundation and the University of Nebraska Foundation provided support for the conference.

In 2009 the University of Nebraska and the Bill & Melinda Gates Foundation hosted the Future of Water for Food conference to bring together experts from around the world to discuss the research and leadership needed to meet this challenge. More than 300 representatives of universities, industry, government and nongovernmental organizations from the U.S. and nations ranging from Australia to Zambia participated in the May 4-5 conference at UNL.

Jeff Raikes, CEO of the Bill & Melinda Gates Foundation, set the stage with his keynote address "Fighting Poverty with Water."

"Water is key. It's a critical issue," Raikes said. "So it's time for all of us to come together and demand of ourselves... new innovations, new approaches, because collectively you have the power to help hundreds of millions of people move from extreme poverty."

Other speakers included Peter Rogers, Harvard University; Simi Sadaf Kamal, the Hisaar Foundation, Pakistan; Richard Allen, University of Idaho; Robert Glennon, University of Arizona; and Jim Goeke, UNL. Panel discussions focused on key issues in science, technology, policy and the human dimensions of water use for agriculture.



Science and technology panel

Sensor System Detects Track Troubles

With thousands of miles of railroad tracks passing through often remote country, finding problem spots is a needle-in-a-haystack challenge.

Using knowledge gained from his previous work in robotics, UNL mechanical engineer Shane Farritor and colleagues developed a rail sensor system that finds those needles before they cause devastating and costly derailments.

A laser sensor, mounted on a railcar, searches for problems by measuring the track's stiffness. At a weak spot, the track bows under the passing car's weight. The sensor measures the shape of the rail, and an onboard computer sends the information, including GPS coordinates, to Farritor's UNL lab. Researchers have tested the device on more than 25,000 miles of track.

"When you go out there, you'll know why we got that measurement," said Farritor. "We're getting better at localizing and prioritizing spots that would not have otherwise been found."

Railroads visually inspect and measure tracks to identify problems, but "no one has made practical measurements of the vertical stiffness before. We think it's one of the more important parameters there is because the track has to support those heavy trains," Farritor said.

The device operates independently during a train's regular operation, which should make it inexpensive. The Department of Transportation's Federal Railroad Administration funds this research. The Union Pacific and Burlington Northern Santa Fe railroads have provided access to their rails and other support. UP donated a coal car for the project.



Part of sensor system on railcar

Heavy loads from extensive freight train traffic across Nebraska and the region cause substantial track wear, making the freight rail industry a primary potential beneficiary of this technology. The sensor also could detect problems on commuter rails, potentially saving lives.

Farritor is refining the sensor and expects to have a commercially viable product soon. UNL recently licensed a series of rail measurement technologies to MRail Inc., a Nebraska startup company. Inventors are UNL engineers Farritor, Joseph Turner, Richard Arnold and Sheng Lu.



Shane Farritor

"We're getting better at localizing and prioritizing spots that would not have otherwise been found."

Better Packing Peanuts

Durable plastic packing peanuts protect fragile items during shipping, but static cling makes them a pain to handle.

Starch-based peanuts made from renewable corn are static-free and biodegradable. They dissolve in water, a plus for easy disposal but a drawback in wet or humid conditions.

UNL Industrial Agricultural Products Center engineers invented a technique that combines cornstarch and petroleum-based polystyrene to make packing peanuts with the best characteristics of both. Milford Hanna, the biological systems engineer who heads the center, and his team developed a patent-pending

process to create peanuts made mostly of starch with a small amount of polystyrene.

“The physical properties of our material are more like polystyrene but without the static problem,” said Marvin Jaques, senior licensing manager for NUtech Ventures, formerly UNL’s Office of Technology Development. “The manufacturing process is similar to the straight starch product.”

While the UNL product isn’t biodegradable, it’s made primarily from renewable resources, holds up to water and is static-free. Uses of UNL’s technology could include insulating foam sheets or other plastic foam applications.



Robert Weber (left) and Milford Hanna

StarchTech Inc., a Minnesota-based manufacturer of biodegradable starch packing peanuts, has an exclusive contract with UNL to commercially produce the hybrid packing peanuts.

Precast Pole System Eases Installation

As utility poles need replacing because of age or natural disasters, utility companies are seeking alternatives to traditional wooden poles.

Precast concrete poles are gaining popularity because they’re strong, less expensive than steel and require less maintenance than wood, but weight and size can make installation difficult.

A segmental concrete pole system, developed by UNL civil engineer Maher Tadros, makes installation easier. His invention employs 30-foot

segments of precast concrete. Each segment is reinforced with post-tensioned strands of fiberglass-reinforced plastic rebar for added strength. Segments can be used alone or joined to create a single tower up to 120 feet tall or a tripod reaching 240 feet. The result is a lighter, stronger, taller pole that is easy to transport and assemble on site.

Tadros, a researcher at the University of Nebraska’s Peter Kiewit Institute, developed a manufacturing process that ensures the poles

are less susceptible to vertical cracking under extreme conditions than concrete poles made with other production methods.

UNL has patented the technology, which has potential applications for utility poles, telecommunications and wind turbines.

Superior Power Poles Inc., a Texas company, has an exclusive license to produce the poles using UNL’s technology.

Investigating Blasts’ Impact on Brain

Improvised explosive devices, or IEDs, the infamous weapons used against troops in Iraq and Afghanistan, cause the most injuries.

With a nearly \$3.3 million Department of Defense grant, a team of 10 UNL engineers is collaborating with the U.S. Army to investigate the effects that pressure waves from IED blasts have on the brain. Researchers suspect these blasts may cause mild to severe traumatic brain injuries that may only become apparent months or years later.

“We are answering a national and even an international need,” Namas Chandra, professor and associate dean of engineering who leads this initiative, said of this research.

Traumatic brain injuries may result from atmospheric pressure changes caused by blast waves. High pressure passes through helmets and skulls, damaging the brain at the cellular level.

Even mild traumatic brain injury with few initial symptoms may cause slow deterioration over time, but these injuries are still poorly understood.

To study these effects, UNL engineers are developing a simulated human head and



Namas Chandra

building a blast facility to generate controlled pressure waves. The unique approach uses experiments, modeling and simulation to understand wave impact at the cellular level. They hope the research will one day lead to better personal protection devices.

UNL engineers bring extensive expertise and years of research in materials, personal protection systems and blast wave simulation to this research. The collaborative project includes Army and Department of Energy research laboratories and others.

There is wide interest in the project, and Chandra expects the two-year grant will lay groundwork for continued research.

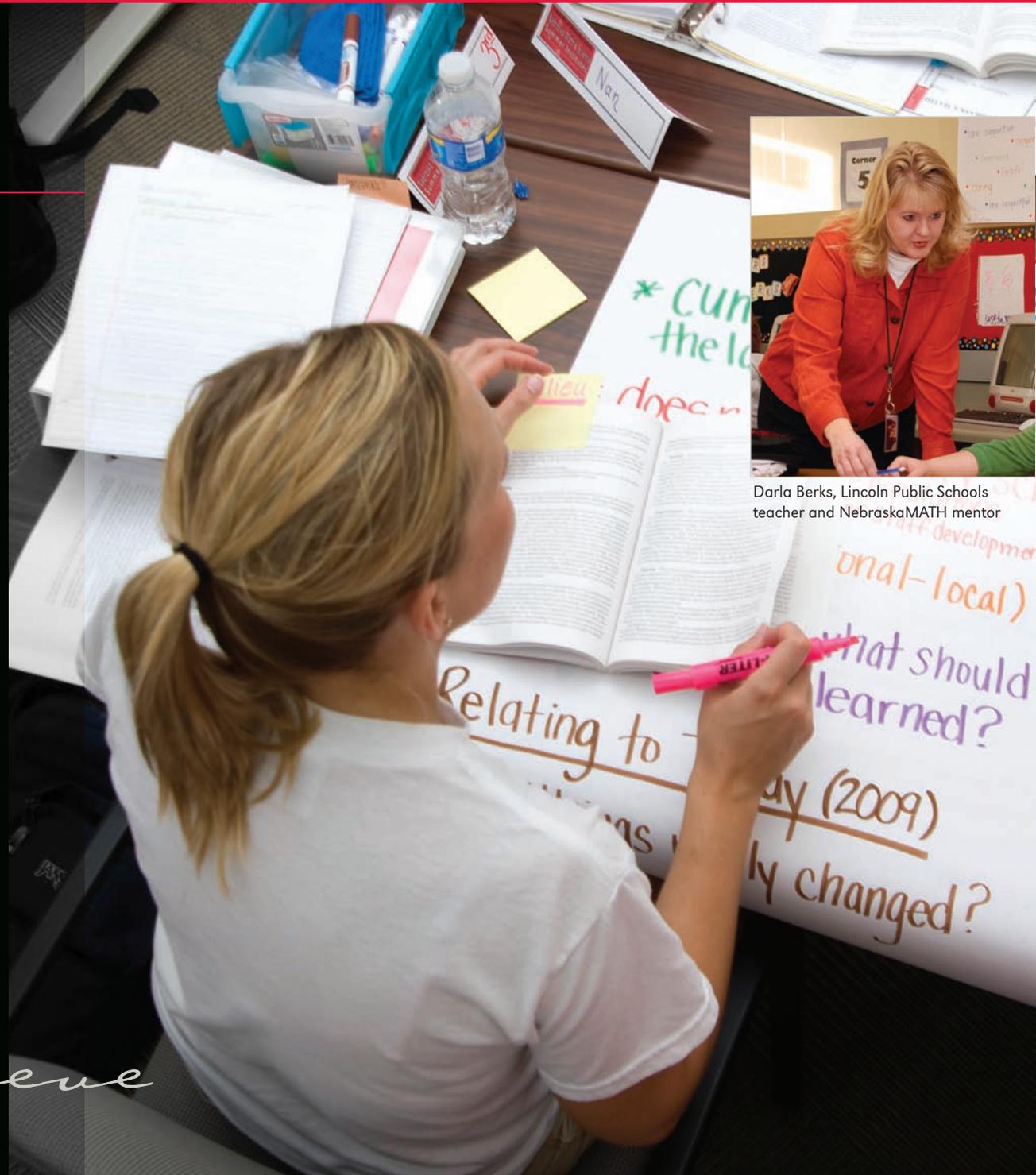
“This work will really put Nebraska on the map of traumatic brain injury work. We are not going to answer all of the questions, but we are going to figure out a significant part of the puzzle.”

Each year, an estimated 1.4 million Americans suffer traumatic head injuries. Ultimately, this research could help protect the public as well as U.S. troops.

Partnering on Math Achievement

“Our goal is to better understand what mathematical attitudes, knowledge and habits of mind K-3 teachers need to possess to best help young children acquire strong mathematical foundations.”

Achieve



Darla Berks, Lincoln Public Schools teacher and NebraskaMATH mentor

Until 10 to 15 years ago, many educators believed that in-depth math education could wait until high school. Research has dramatically changed those attitudes.

NebraskaMATH, a statewide partnership led by UNL researchers, aims to narrow

the achievement gap for at-risk students in kindergarten through third grade and improve mathematics achievement for all students.

A \$9.3 million grant from the National Science Foundation provides resources for teachers to take graduate mathematics courses that strengthen their skills.

“Our goal is to invest in teachers,” said Jim Lewis, project leader and mathematics professor. “In turn, we hope they are better prepared to challenge their students and become leaders within their districts.”

The first teachers began classes in June 2009. Three hundred teachers are expected to participate during the five-year project, which has the potential to benefit 40,000 K-3 students and 10,000 high school students across Nebraska.

An important element of the project is studying how different approaches in K-3 math education, such as math coaches and classroom teachers who work as math specialists, affect young children’s learning. Ruth Heaton, associate professor of teaching, learning and teacher education, leads this multidisciplinary research.

“Our goal is to better understand what mathematical attitudes, knowledge and habits of mind K-3 teachers need to possess to best help young children acquire strong mathematical foundations,” Heaton said.

NebraskaMATH includes two other programs: one helps algebra teachers reach at-risk students;

another offers professional development opportunities for new mathematics teachers.

The initiative builds on UNL’s successful Math in the Middle program, another NSF-funded project that enabled 125 middle-level mathematics teachers to earn master’s degrees.

The NebraskaMATH partnership includes Grand Island Public Schools, Lincoln Public Schools, Omaha Public Schools, Papillion-La Vista Public Schools and Nebraska’s Educational Service Units. Lewis said it is a truly statewide effort that can serve as a national model for collaboration between state universities and K-12 schools.



Ruth Heaton and Jim Lewis

Exploring Complex Social Dynamics

Improving Child Welfare Services



Mark Ells and Michelle Graef

For a family in crisis, navigating the vast child welfare system can be daunting.

Child welfare agencies have the expertise to help. However, limited resources and lack of communication among agencies sometimes delay assistance for children and families.

A new UNL-based center is working to improve the quality and effectiveness of child welfare services in Nebraska and the region. The Midwest Child Welfare Implementation Center partners with state and tribal child welfare agencies to identify obstacles to helping families and to recommend significant changes for improving services. The goal: helping agencies function more effectively and ensuring all children have safe, stable and permanent homes.

“There are families falling through the cracks. Do we have the right kinds of services and, if so, are families finding out about them?” said Michelle Graef, project co-leader and research associate professor in UNL’s Center on Children, Families and the Law, which administers the center.

UNL researchers provide consultation and support to state and tribal child welfare agencies in Nebraska, Iowa, Illinois, Indiana, Kansas, Michigan, Missouri, Minnesota, Ohio and Wisconsin.

For example, the center may examine how an agency recruits and retains employees, how well it coordinates with law enforcement and the court system, or how quickly it connects families with medical or mental health services. Improvement projects are tailored to agencies’ individual needs and tribes’ cultural values.

A five-year, \$8.7 million grant from the U.S. Department of Health and Human Services Children’s Bureau funds the effort. UNL is one of five regional implementation centers established to better coordinate resources and expertise provided by the Children’s Bureau’s training and technical assistance network.

“We’ll know our work has been successful if families receive the services they need and foster children get to permanent homes more quickly,” said Mark Ells, project leader and research assistant professor in the Center on Children, Families and the Law.

Why does one person vote republican and another democrat? Why do some people tend to trust a stranger more readily than a spouse?

Answers aren’t found just in a person’s environment, experiences or genes, but in a combination of many influences. An innovative new initiative – Systems Biology of Social Behavior – is bringing together UNL researchers from diverse disciplines to explore complex social dynamics.

“It’s a little weird to have political scientists working with geneticists,” admits the initiative’s director, political scientist Kevin Smith. “But there’s a growing recognition that we’re unlikely to fully understand why people or animals do the things they do socially within the confines of a single discipline.”

This research one day could expand knowledge about how we learn and make decisions, and help people understand each other’s differences, which might help us better manage conflicts.

For example, Smith and colleagues study the roots of ideologies. “There’s a lot of work indicating that political attitudes are partially inherited. It’s not just what mom and dad talk about at the dinner table.”

By studying identical twins and physiological responses such as visual tracking and brain activity, researchers are linking ideological beliefs across a wide spectrum, from social interactions to cognition and even to DNA.



Kevin Smith (standing) and graduate student Douglas Oxley

While research often focuses on narrow aspects of human social behavior, this initiative envisions a comprehensive approach. Researchers will incorporate genetics, neuroscience, physiology, affect/emotion, cognition and group dynamics to understand the systems biology behind human social behavior.

UNL is well positioned to tackle such complex questions, thanks to nationally known researchers in biology, neuroscience, cognition and political science who are willing to work collaboratively outside their disciplines, Smith said.

UNL also plans to train a new generation for cross-disciplinary research through a graduate program that will require students to take classes and work outside their fields.

“This is a way to make disciplinary boundaries a little more permeable,” said Smith, and to prepare students to work collaboratively.

Focusing on Rural Schools' Unique Needs

Rural schools have unique needs and challenges, yet research about how rural educational settings influence student learning and development is limited.

UNL's new National Center for Research on Rural Education aims to close that knowledge gap. Established in 2009 with a five-year, \$10 million grant from the U.S. Department of Education Institute of Education Science, it is the only such center in the U.S. It will provide the research, infrastructure, leadership and expertise to focus on rural education needs.

Improving student learning in reading, science and math is the goal. To achieve this, researchers are studying how best to provide professional development support to rural teachers. Answers could guide improvements in professional development and instructional practices for rural teachers across Nebraska and the nation.

Rural schools offer many advantages, including family involvement, community support and close relationships, said Susan Sheridan, professor of educational psychology who leads the center. However, geographic isolation can hinder teachers' access to formal professional development programs and limit informal peer mentoring that sharpens their classroom skills.

"Rural teachers don't always have access to the most up-to-date, research-based programs and strategies that are available in cities with universities and research centers closely aligned to the schools where the research is taking place," Sheridan said.

Researchers are working with rural schools to identify and test methods of delivering professional support that enable teachers to bring the most effective instructional strategies into their classrooms. More than

500 Nebraska teachers will participate in this research through training, one-on-one coaching and practicing new research-based methods.

Payoffs could be far-reaching. Nationally, nearly 10 million youth attend school in rural areas. In Nebraska, almost 30 percent of students attend rural schools, and 87 percent of the state's school districts are considered rural. At least 5,000 Nebraska students will benefit from their teachers' involvement in this research.

"We are just now starting to understand the rural context as something that's unique and distinct that needs to be addressed in its own right," Sheridan said.

Facing page, from left: James Bovaird, Gina Kunz, Todd Glover, Susan Sheridan and Gwen Nugent



Innovate

"We are just now starting to understand the rural context as something that's unique and distinct that needs to be addressed in its own right."

A Gut Feeling

Scientists working at the intersection of agriculture and human health envision UNL as a pipeline for new products that make for healthier people. It all runs through the gut – quite literally.

Experts in gastrointestinal microbiology, bioinformatics and statistics, immunology, allergies, metabolomics, quantitative genomics, physiology and nutrition have teamed through UNL's Gut Function Initiative to understand the microorganisms that live in the gastrointestinal tract. Ultimately, they hope to transform that understanding into new crops, products and practices, including so-called functional foods, that improve health and fight disease.

Building on UNL strengths in food science, nutrition, and crop and livestock production, the initiative aims to put the university on the leading edge of this emerging research. Grants from the National Institutes of Health and the U.S. Department of Agriculture support this work.

"This is a new interface between agriculture and human health," said food microbiologist Andy Benson. "The newest ideas to emerge at this interface can be quickly integrated into the engines of agricultural production."



Andy Benson

The goal is simple: find ways to maximize good microbes and minimize bad ones. Getting there is astoundingly complex. Researchers estimate the gut has 10 times more microbes than there are cells in the human body.

Scientists must understand how to encourage beneficial microorganisms that aid digestion, stimulate cell growth, train the immune system, break down toxins and defend against disease, and to discourage microorganisms linked to obesity, coronary disease, cancer, inflammatory bowel disease and other diseases.

A key is UNL's new gnotobiotic facility, one of about 10 nationwide, where scientists breed mice in a sterile environment and experiment with introducing specific bacteria into their GI tracts to learn about each microbe's function.

"Many of the most significant discoveries in human medicine are likely to occur in the GI ecosystem in the next 10 to 20 years," Benson said. UNL's team has the food and nutrition science expertise to make some of those discoveries and the agricultural expertise to turn that knowledge into new crops or products.

Of Mice and Health

A tiny mouse living high in the mountains is providing evolutionary clues that might someday help people with blood and lung disorders.

UNL evolutionary biologist Jay Storz is comparing the genetics of deer mice living at high altitudes with those of their relatively oxygen-rich lowland kin to understand how animals evolve to adapt to low-oxygen environments. These evolutionary insights could lead to treatments for health problems such as chronic obstructive pulmonary disease, or COPD, the fourth leading cause of death in the U.S.

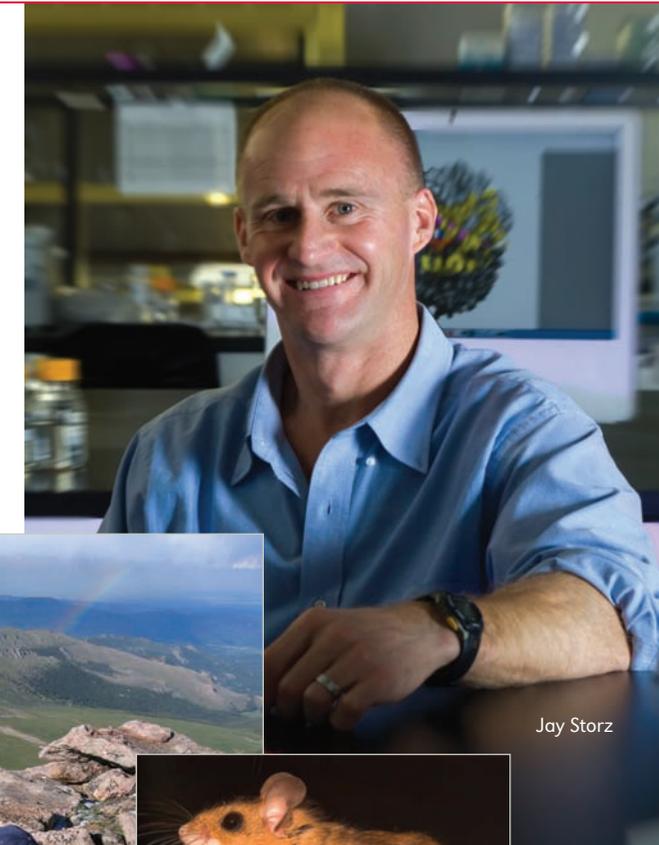
With funding from a \$1.3 million, five-year National Institutes of Health grant, he is investigating hemoglobin, a protein that binds with oxygen in the lungs and transports it throughout the bloodstream. When oxygen is scarce, animals must take greater advantage of the available supply. High-altitude mice have evolved the ability to maximize the uptake of oxygen they breathe by more efficiently capturing the available oxygen in their hemoglobin.

"The hemoglobin system in high-altitude deer mice illustrates the solution that evolution has come up with to deal with hypoxia (oxygen deficiency)," Storz said.

The ability to capture and circulate more oxygen could help people with disorders such as anemia, cardiovascular disease and COPD that reduce oxygen transport efficiency. Understanding the mechanisms responsible for evolutionary adjustments in hemoglobin function can be used to design therapies, such as blood substitutes, that can either increase or decrease hemoglobin's ability to bind oxygen in humans.

Storz collaborates with UNL School of Biological Sciences colleague Hideaki Moriyama. They're combining evolutionary biology with biotechnology to identify genetic mutations responsible for changes in hemoglobin function and to understand how those mutations work together to produce changes.

Storz led an international team that recently identified mutations in four hemoglobin genes that enable high-altitude deer mice to tolerate chronic hypoxia. Findings were reported in the *Proceedings of the National Academy of Sciences*.



Jay Storz



Setting traps in Colorado



Deer mouse

Deciphering Nutrigenomics Puzzle



Tim Carr (left) and Janos Zempleni

The days of one-size-fits-all dietary recommendations are numbered. Tomorrow's recommendations will match foods with your unique genetic makeup to prevent disease.

That's the promise of nutrigenomics, the intricate interaction among food, genetics, health and disease. Deciphering this complex genetic and nutritional puzzle requires multidisciplinary expertise.

At UNL, the new Nebraska Gateway to Nutrigenomics, or NGN, integrates research in this emerging field. The initiative, launched in October 2008, involves 28 faculty members from 11 UNL departments.

"We believe nutritional genomics will be the future of nutrition and the future of health care and preventive medicine," said Tim Carr, a nutrition science professor who co-directs the initiative. "We want to be leaders in the field. We believe it's going to be good for Nebraska and all of the Midwest."

Nutrigenomics involves identifying the unique genetic makeup of individuals or population groups and determining their genetic predisposition to birth defects and diseases



such as cancer, cardiovascular disease or diabetes. Scientists also must understand how foods' diverse components interact with different genetic scenarios.

Armed with that information, a person could eat an individualized diet rich in nutrients to counter a specific genetic predisposition and prevent disease.

For example, scientists know some single-nucleotide polymorphisms, or SNPs – variations in the DNA sequence of one nucleotide – increase the risk for certain diseases. For one known SNP, a diet rich in folate may reduce heart attack and birth defect risks.

For many other SNPs, the connection between genetics and disease remains unknown. Scientists need to explore other genetic factors to determine whether or how dietary interventions influence them.

The NGN is enhancing UNL's research efforts. "We're creating synergies among faculty and across departments," said Janos Zempleni, director of the initiative and associate professor of nutrition science. Grants from the National Institutes of Health, National Science Foundation, U.S. Department of Agriculture and other agencies support NGN faculty research.

"We believe nutritional genomics will be the future of nutrition and the future of health care and preventive medicine."

Shear Heads NU Press

Being named *ForeWord Magazine's* Independent Publisher of 2008 is among the latest indicators of the quality and talent at the University of Nebraska Press, said Donna A. Shear, who became UNP director in March 2009.

Victoria Sutherland, *ForeWord's* publisher, called UNP "a publisher that excelled in its



Donna Shear

role of keeper of the cultural heritage, a university publisher that has deliberately made a place for itself in the world of trade as the curator of consistently wonderful books in several special markets."

Shear said she sees opportunities for UNP to build on its strengths by expanding its regional publishing program throughout the Great Plains. She also hopes to explore opportunities in electronic publishing.

A veteran of scholarly publishing, Shear came to UNL from the Northwestern University Press in Evanston, Ill., where she was director. She holds an MBA from the University of Toronto and a bachelor's degree in political science from Rutgers University.

UNP is a nonprofit scholarly and general interest press that publishes 160 new and reprint titles annually under the Nebraska and Bison Books imprints, and 25 journals. As the largest and most diversified university press between Chicago and California, with nearly 3,000 books in print, the Press is best known for publishing works in indigenous studies, western American history, literary translation and sports history.

Anderson Leads Industry Relations

UNL is expanding partnerships with business, industry and private foundations.



Ryan Anderson

"We have some exciting opportunities to build existing and new private-public partnerships to advance the university and enhance economic development for Nebraska," said Ryan Anderson, who joined UNL as director of industry relations in late 2008.

He is especially interested in expanding industry relationships in areas of research strength, including life sciences, agricultural biotechnology, transportation, energy, water and nanoscience. He also will foster private-sector relations to develop the Nebraska Innovation Campus at UNL.

"Industry and our university both benefit from collaborations," Anderson said.

Anderson came to UNL from the University of Nebraska Foundation where he worked in corporate and foundation relations and development, most recently as director of foundation relations. He has a bachelor's degree from UNL.

Supercomputing Power Expands

The recently expanded Holland Computing Center doubles the University of Nebraska's high performance computing capacity and positions the university to become a leading regional resource for computing research. The center integrates supercomputing resources at UNL's Research Computing Facility and at the University of Nebraska's Peter Kiewit Institute in Omaha, in a single universitywide high performance computing center that serves all campuses of the university system.

Researchers benefit from improved capacity to perform complex computer simulations that

are vital to research in a number of disciplines, including water, bioinformatics, transportation and climate research. The center includes UNL's Prairie Fire and Red supercomputers and PKI's Firefly supercomputer. Having hardware in two locations provides redundancy important for security, data storage and integrity, said David Swanson, the UNL computer scientist who directs the new center and previously led UNL's Research Computing Facility.

"To realize our potential, we must have the computing capacity to support our faculty. That is the promise of the University of Nebraska



David Swanson

Holland Computing Center – that faculty in all disciplines will have the computing resources they need to put Nebraska on the map," NU President James B. Milliken said.

The Holland Center expansion was made possible by a gift from Omaha businessman and philanthropist Richard Holland.

Shaping Climate Change Research

A climate change conference report, focused on the importance of sustaining agricultural production in the face of climate change, is helping UNL and U.S. Geological Survey scientists shape plans to comprehensively study climate change across the High Plains.

The report, *Sustainability in a Time of Climate Change: Developing an Intensive Research Framework for the Platte River Basin and the High Plains*, details the issues, perspectives and research recommendations from the 2008

conference and companion workshop. UNL and USGS jointly hosted the conference at North Platte, Neb., which drew about 150 UNL and USGS researchers, representatives from state and regional organizations, farmers, ranchers, resource managers and policymakers to discuss regional challenges of a changing climate.

The report is shaping the research agenda as UNL and USGS researchers continue collaborations on specific research plans. It also has been shared widely with decision-makers and federal agencies.

"UNL and USGS believe that by combining our expertise and building on our existing activities in this region, we can develop a comprehensive research plan that will help us find resilient, science-based solutions to the challenges we face in a changing climate," project leaders wrote in the report's foreword.

The report is available online at: research.unl.edu/docs/climatechangereport_final.pdf

Debugging Complex Software

When Myra Cohen's computer software crashes, it's a good day.

In fact, the more software bugs the UNL computer scientist finds, the better she's doing her job. Cohen develops testing procedures for complex software, and she has been catching lots of bugs.

"In testing, it's good to find a fault," Cohen said. "We're looking for more ways to efficiently and effectively run tests to uncover more problems before they get out to the public."

Poor software quality adds up to tens of billions of dollars in financial losses annually in the U.S., according to the National Institutes of Standards and Technology. Glitches in medical, military or other essential software could put lives at risk.

Two prestigious grants help fund Cohen's research on better ways to debug complex software systems. She is the first UNL faculty member to receive a \$320,000, three-year grant through the Air Force Office of Scientific Research's Young Investigator Program, which funds young researchers with exceptional ability and promise in basic research. She also has a \$400,000, five-year National

Science Foundation CAREER Program award, which supports outstanding pre-tenure faculty.

Cohen has been testing highly configurable software, such as Web browsers, that allow users many preference options. Changing preferences alters the underlying program, so testing only default settings, as is normal, may not suffice. She's developing a technique to more comprehensively and reliably test the myriad combinations of options in configurable software.

With the Air Force grant, she is expanding her research to develop tests for entire product lines, such as cell phones, which combine hardware with software. Instead of testing each new model from scratch, Cohen's techniques use information from the previous model to test the new one, allowing efficient testing across entire families of products.

She likens it to car assembly lines. If every car has the same engine, but different tires, it may be necessary to test only the new tires.

Improved product line testing techniques should benefit software companies, the military, medical technologies, and ship and airplane industries.

"We're looking for more ways to efficiently and effectively run tests to uncover more problems before they get out to the public."



Myra Cohen





Laying Innovation Campus Groundwork

Plans are taking shape for Nebraska Innovation Campus, a private-public research community designed to strengthen Nebraska's economy and enhance UNL research.

Innovation Campus will be developed on about 250 acres adjacent to UNL near downtown Lincoln. Officials envision creating private and public research and technology space where entrepreneurs and private companies work closely with UNL faculty and students in an innovative environment. The project will build UNL's research capabilities, strengthen private-public collaborations, attract businesses that create jobs and expand Nebraska's economy.

"As we share our vision for Innovation Campus with people across the country, we're finding enormous enthusiasm," said UNL Chancellor Harvey Perlman. "It reinforces our belief that this is a unique opportunity to harness the economic potential of our research to benefit Nebraska for generations to come."

UNL laid groundwork for the campus in 2009, hiring consultants, meeting with potential partners and expanding efforts to build relationships with business and industry. At a Research Strengths Summit in June, faculty and industry representatives discussed UNL's research capabilities and industry interests, and identified key strengths and considerations for Innovation Campus.

The university selected SmithGroup/JJR of Ann Arbor, Mich., as the master planner, and Noddle Development of Omaha, Neb., as the business strategy planner for the project. The master plan and business development strategy are due Dec. 1. In January 2010, UNL will obtain the Innovation Campus site, which previously housed the Nebraska State Fair. The fair is moving to Grand Island, Neb. Early in 2010, the university will select a developer for Innovation Campus.

The site has between 1 million and 4 million square feet of space suitable for construction. Private companies and UNL will develop this mixed-use space as demand increases and private and public funds become available over the next 20 or more years.

Enhancing International Partnerships

New research and education partnerships forged with China and India are expanding UNL's tradition of global engagement.

During the last year, UNL administrators and faculty met with university, government and industry officials in China and India to discuss collaborative research and education programs. UNL officials signed agreements with major universities in each country to create joint degree programs and research partnerships in areas such as agriculture, engineering, transportation, virology and water.

In early 2009, UNL officials visited several universities and research organizations in India, building partnerships and laying groundwork for broader collaborations.

Officials from UNL and Anna University in Chennai, one of India's top engineering schools, agreed to launch a joint engineering doctoral program and collaborative research. A research agreement with the International Crops Research Institute for the Semi-Arid Tropics, known as ICRISAT, will expand research opportunities and give UNL plant science graduate students the chance to conduct research in India. A partnership with India's Ministry of Food Processing Industries will bring Indian

government researchers to UNL to learn about food processing practices.

In China, a UNL delegation attended a Confucius Institute board of directors meeting, discussed partnerships with officials from Zhejiang and Xi'an Jiaotong universities and met with officials involved in ongoing collaborative AIDS research. UNL previously established partnership degree and faculty exchange programs with Xi'an Jiaotong and Zhejiang city colleges and launched a Confucius Institute site in 2007.

Agricultural development is a priority for China, and UNL agricultural scientists are working with Chinese scientists from Zhejiang University to establish an experiment station and irrigation demonstration project.

In a separate project, UNL and Hohai University scientists are partnering on international water research to develop a cyber-infrastructure for global water research. The U.S. and Chinese National Science Foundations help fund this project.

UNL officials also met with representatives from the U.S. Centers for Disease Control's Global AIDS Program in China. UNL scientists work with the U.S. and Chinese CDCs on HIV/AIDS research. The National Institutes of Health funds this research by UNL virologist Charles Wood.



Touring ICRISAT



Chancellor Harvey Perlman (right) at Anna University



Signing ICRISAT research agreement

Tackling Human Trafficking

As a UNL marketing professor, slavery was not on Ron Hampton's radar. But after a student from Ukraine mentioned the problem in that country, Hampton flew there to investigate and decided to study human trafficking from a marketing perspective.

After meeting some victims and publishing research on the marketing aspects of trafficking, Hampton and UNL marketing colleague, Dwayne Ball, recruited other UNL faculty to study and raise awareness of this global problem. The multidisciplinary team includes experts in economics, ethnic studies, history, journalism, law and library sciences, among others.

Human trafficking, the movement of humans across borders to enslave them, fuels the sex trade, organ extraction, forced labor and other forms of debt bondage. Though illegal, slavery remains the third largest and fastest growing industry worldwide.

Experts estimate 27 million people currently are enslaved globally, including as many as 200,000 in the U.S. A lack of reliable data on trafficking exacerbates the challenge of guiding policy and anti-trafficking efforts.

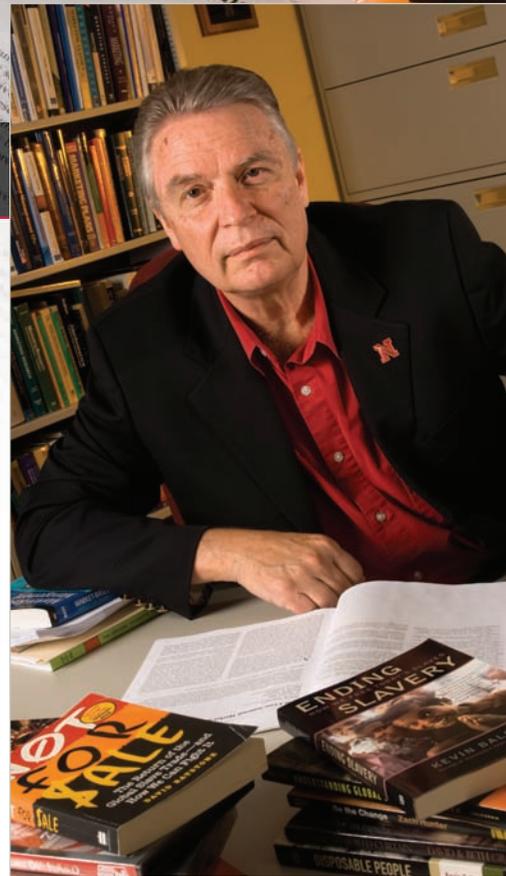
"It's happening daily all over the world," including places like Nebraska, Hampton said, and policies, including those in the U.S., are lacking.

The UNL team aims to focus on human trafficking research needs and findings by hosting an annual interdisciplinary conference that brings together researchers and representatives from government and nongovernmental agencies. The first, in October 2009, will develop a research agenda.

Researchers hope to create a multidisciplinary center at UNL as an information clearinghouse for academics, government officials and others.

Law professor Josephine Potuto said that centering the project in Nebraska instead of a larger city "allows for a broader investigation of a larger number of subjects that might get lost if it were put someplace else."

By generating interest and research in human trafficking, the team hopes to find novel approaches and policy solutions that will one day help end human trafficking globally.



Ron Hampton

Opera's Winning Ways

For the third time in 10 years, UNL's School of Music won the National Opera Association Award for Best Production, an honor that underscores the ongoing quality of its opera.

Opera director William Shomos, professor of music, attributes the success to the school's focus on its students and choice of productions in which they can excel.

"Our mission is to serve the students and provide them the opportunities to spread their wings, to explore, to discover who they are and how they fit into this art form," he said.

Attention to students' growth, not competitions, translates into high-quality performances. "The awards are nice, but it's not what drives us."

Winners are chosen by a panel of opera professionals without knowing which schools submitted the video productions. UNL's winning 2008 performance was *Dead Man Walking*, inspired by Sister Helen Prejean's book, which also was made into a 1995 movie.

Awards are but one measure of the school's success. Numerous students, like Kelly Ellenwood and John DeHaan, have gone on to prestigious careers starring on Broadway and as internationally acclaimed singers. Recent graduate Ken Floyd now sings for the Metropolitan Opera.



Scene from *Dead Man Walking*

Star alumni include many popular high school choral directors who bring their enthusiasm and artistic talent to teach a new generation of students.

Shomos said tremendous community support and loyal audiences contribute to student success. "The UNL Friends of Opera is a group of not only opera enthusiasts, but also student enthusiasts who really give of their time and

their treasures to help make this program as strong as possible," he said.

To give back, the opera program reaches out to Lincoln's young people with performances including the annual *Amahl and the Night Visitors* about overcoming life's obstacles. Students are enthralled and UNL is creating audiences for the future.

Determined to Make a Difference

It's a remarkable journey from an uncertain childhood as a Sudanese refugee to UNL graduate student and Fulbright grant winner. For Nithal Kuwa, it's the path to her dream of improving African health care.

Kuwa is in Zambia studying HIV drug resistance in children. This follows her master's degree research with Charles Wood, UNL molecular virologist and AIDS researcher who directs the Nebraska Center for Virology. She'll graduate in December 2009. For her Fulbright, Kuwa is working with researchers in Wood's lab in Zambia and volunteering at a local counseling and testing center.

"What I am going to do will be important for the development of better drug regimens for children," Kuwa said.

Babies born to HIV-positive women who receive drugs to prevent transmission sometimes inherit the virus anyway. Kuwa is investigating whether those children are more likely to develop resistance to HIV treatment later. About 1.8 million children in sub-Saharan Africa live with HIV/AIDS.

As Wood's graduate student, Kuwa studied immune response to a herpes virus that often



causes an aggressive cancer in HIV/AIDS patients. Wood studies HIV and HIV-associated viruses, focusing on transmission and their roles in immunosuppression and cancer development. Through his lab and clinic at the University of Zambia, Wood works closely with local scientists on HIV/AIDS.

Born in Sudan at the beginning of its civil war, Kuwa spent most of her childhood living in Ethiopia and Kenya before arriving in Lincoln, Neb., in 2000 as a teenager with her mother and siblings.

She excelled academically. During college she was so moved by her summer volunteering in a Sudanese hospital she decided to one day return to Sudan to help. Following her Fulbright experience, she plans to pursue a doctorate in public health.

"I hope that my being there and seeing their faces will give me motivation to put even more into my work," Kuwa said. "Hopefully in the future, I'll make a difference in someone's life."

Stimulus Bolsters Research

UNL faculty are aggressively pursuing funding available through the American Recovery and Reinvestment Act of 2009 to expand their research and scholarship, and to help stimulate the nation's economy.

The stimulus package, which provides unprecedented funding for research, infrastructure and education, is designed to jump-start the economy and create or retain jobs. Prem Paul, UNL vice chancellor for research and economic development, said stimulus funding will lead to new technologies and information with short- and long-term economic benefits. "Money spent on research creates and retains jobs," Paul said. "These dollars will be spent in Nebraska and will truly have multiple benefits for our economy."

UNL faculty are successfully competing for stimulus funding, Paul said. Examples of early success included:

- A \$375,670, two-year grant from the National Institute of Allergy and Infectious Diseases to Robert Powers, associate professor of chemistry, for research to enhance his team's functional annotation screening technology by nuclear magnetic

resonance spectroscopy (FAST-NMR) assay. Perfecting this tool will help researchers determine the function of proteins identified by gene sequencing and their therapeutic potential in developing new drugs.

- A \$360,000, three-year grant from the National Science Foundation to Jeffrey Shield, professor of mechanical engineering, to establish a Research Experiences for Undergraduates (REU) program in nanomaterials and nanoscience. Sponsored by the Nebraska Center for Materials and Nanoscience, this REU will build on UNL's research strengths in nanotechnology. It will bring to campus students from colleges and universities that lack a strong research emphasis, especially those in the upper Midwest, as well as students from underrepresented groups for 10 weeks of intensive research with UNL faculty.

- A \$300,002, three-year NSF grant to Li Tan, assistant professor of engineering mechanics, for research exploring how best to produce free-standing nanoparticle fibers that could be used to make far more efficient organic photovoltaic cells.

Credits

The 2008-2009 Annual Report is published by the University of Nebraska-Lincoln Office of Research and Economic Development. More information is available at <http://research.unl.edu> or contact:

Prem S. Paul

Vice Chancellor for Research and Economic Development
301 Canfield Administration Building
University of Nebraska-Lincoln
Lincoln, Nebraska 68588-0433
(402) 472-3123 • ppaul2@unl.edu

Writers/Editors:

Vicki Miller, Monica Norby, Ashley Washburn, Elizabeth Banset, Office of Research and Economic Development

Contributing Writers:

Gillian Klucas, Daniel R. Moser
Some articles are based on earlier stories by:
Kelly Bartling, Sara Gilliam, Steve Ress, Tom Simons

Photography/Illustrations:

Joel Brehm, Brett Hampton, Craig Chandler,
Alan Jackson/Jackson Studios, Lincoln Public Schools,
UNL School of Music

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More Research Highlights



First Space Law Grads

The inaugural class of the nation's first space and telecommunications law degree program graduated in 2009 from UNL's College of Law. Seven students earned Master of Laws degrees and most landed jobs or internships in the space law field. The space and telecommunications industries are major contributors to the global market and share overlapping legal concerns. UNL launched the space and telecommunications program to meet rapidly growing education, research and information needs. The program's first Washington, D.C., space and telecommunications law conference in November 2008 featured leading experts and government officials interested in the field. More than 115 participants discussed topics including legal and policy aspects of government space programs, risk management and insurance law, wireless technology issues and international concerns.

Digital Whitman

Walt Whitman's Civil War writings are becoming available online thanks to research by UNL English professor Kenneth Price. A leading Whitman and digital scholar, Price co-directs the Walt Whitman Archive, a comprehensive online resource, and co-directs UNL's Center for Digital Research in the Humanities. With a \$300,000 National Endowment for the Humanities grant, Price's team is electronically editing, arranging, annotating and publishing, often for the first time, key documents that give voice to Whitman's experience of the war. Price intends to complete the interdisciplinary project by 2011, in time for the sesquicentennial of the war's outbreak. Price also earned a prestigious Digital Innovation Fellowship from the American Council of Learned Societies and a grant from the National Historical Publications and Records Commission to support this work. Web: whitmanarchive.unl.edu

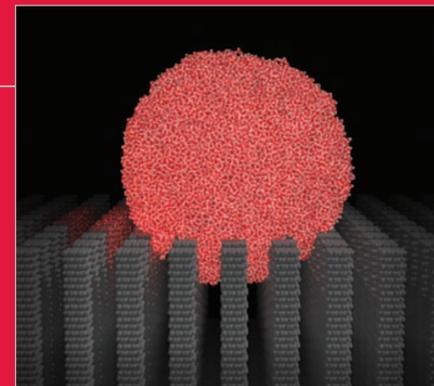
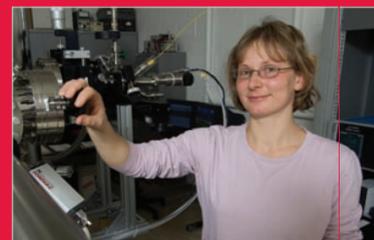


Museum Accreditation

In 2009 the University of Nebraska State Museum again earned accreditation by the American Association of Museums, the highest national recognition afforded U.S. museums. AAM accreditation signifies excellence to the museum community, governments, funders, outside agencies and the public, said museum director Priscilla Grew. The museum has been continuously accredited since 1973. Web: www-museum.unl.edu

Schubert Earns CAREER Award

Materials scientist Eva Schubert is the latest UNL faculty member to earn a National Science Foundation CAREER award, which helps outstanding pre-tenure faculty develop as teacher-scholars and researchers. Schubert is one of a few people in the world studying the potential of a unique type of nano-materials known as hybrid chiral nanostructures. Her research aims to improve the functionality of these materials and test how they perform in electronic devices. Potential applications include storage for library databases, security scanners and biomedical devices.



Understanding Super Hydrophobia

Super hydrophobia – the property that makes water bead and roll off plants and enables water striders to walk on water – has long perplexed scientists. Research by UNL chemist Xiao Cheng Zeng and colleagues at Japan's RIKEN institute reveals clues to how this phenomenon works. Their findings could help engineers develop super hydrophobic materials for self-cleaning countertops, walls and fabrics, water-walking micro-robots and other uses. Using a superfast computer, researchers ran tens of thousands of simulations of virtual raindrops falling on surfaces covered by pillars resembling the microscopic hair-like structures found on water striders or plant leaves. They discovered there is a critical pillar height, depending on structure and chemical properties, beyond which water droplets cannot penetrate. Their findings were published in the *Proceedings of the National Academy of Sciences*.

Biotech Pilot Project

UNL is participating in a U.S. Department of Agriculture pilot project to develop quality management standards for field releases of regulated genetically engineered crops. USDA's Animal and Plant Health Inspection Service selected UNL as the only university to work with four private companies on the biotechnology quality management system pilot project to determine if regulations are reasonable or overly burdensome for universities and industry, and how they could be fine-tuned. UNL carries out more field releases of genetically engineered organisms than any other university, said Dan Duncan, assistant dean of UNL's Agricultural Research Division. Field trials are an important part of the university's biotechnology pipeline that moves research advancements from lab to field.

Robotics and Science Ed

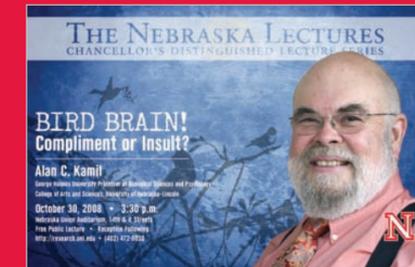
Nebraska 4-H's robotics and GPS/GIS science education curriculum soon will be available to youth nationwide, thanks to a nearly \$2.5 million grant from the National Science Foundation. The 4-H Robotics and Geospatial Project aims to get young people excited about science, technology, engineering and mathematics now and for the rest of their lives. The UNL-developed curriculum has been offered mostly to Nebraska youth. Brad Barker, 4-H technology specialist and a



project leader, said kids learn science and technology concepts while they have fun building and programming small robots. The program targets fifth through ninth graders. The team is scaling up materials and training to make them available across the U.S.

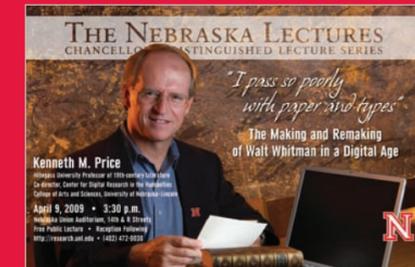
UNL Research Fair

The 2009 UNL Research Fair highlighted faculty and student achievements in research, scholarship and creative activities. The event is a springtime campus tradition, featuring faculty recognition events, presentations from prominent speakers, opportunities to meet federal agency officials, graduate and undergraduate poster sessions, and educational opportunities for faculty and students. The seventh annual fair featured presentations and workshops on diverse topics including federal stimulus funding, international opportunities and working with industry and private foundations. Featured speakers included William Y.B. Chang and Cery Klein, both NSF; Sabine O'Hara, Council for the International Exchange of Scholars; Anthony DeCrappeo, Council on Government Relations; Tobin Smith, AAU; Sidney McNairy and Peggy McCardle, NIH; and Siva Sureshwaran, USDA.



Nebraska Lectures

A behavioral ecologist and a scholar of Walt Whitman described their work during the 2008-09 Nebraska Lectures: Chancellor's Distinguished Lecture Series. In his fall lecture, Alan C. Kamil, the George Holmes University Professor of Biological Sciences and professor of psychology,



discussed how birds use their cognitive abilities to survive in "Bird Brain! Compliment or Insult?" The spring lecture featured Kenneth M. Price, Hillegass University Professor of 19th-century Literature and co-director of UNL's Center for Digital Research in the Humanities. In his lecture, "I pass so poorly with paper and types" – The Making and Remaking of Walt Whitman in a Digital Age," he discussed how Whitman creatively used photography and print media to spread his ideas. The Office of the Chancellor, the Research Council and the Office of Research and Economic Development co-sponsor these lectures featuring prominent faculty.