2006

Office of Research -- Annual Report 2005-2006

ANNUAL REPORT 2005–2006

www.unl.edu/research

University of Nebraska Lincoln | OFFICE OF RESEARCH & GRADUATE STUDIES

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Cover Art:
A photo illustration of the beam path of UNL's Diocles Laser, a 100 terawatt, ultra-fast laser with the highest combination of peak and average power of any laser in the United States.

WELCOME TO RESEARCH AND GRADUATE STUDIES

Research is on the move at the University of Nebraska–Lincoln. In the past year we achieved record levels of external funding, extended our research capabilities into exciting new areas and forged important regional, national and international partnerships.

We have tripled our external funding for research in the past 10 years. New centers in transportation and energy research, a major challenge grant from the National Endowment for the Humanities and significant funding for drought research are among the recent successes contributing to our funding increases. Our major established research centers, including the Nebraska Center for Virology, the Materials Research Science and Engineering Center and the Redox Biology and Plant Genome centers, continue to flourish, attracting talented faculty and advancing the science in their fields.

Chancellor Harvey Perlman and Vice Chancellor for Research Prem Paul

UNL research is establishing a national and international presence in new areas. Our recently dedicated Diocles Extreme Light Laboratory houses one of the world's most powerful, ultra-fast, high-intensity lasers and enables our physicists to pioneer the new research area of high field science. Our Center for Digital Research in the Humanities is being recognized as a national leader in this exciting field. UNL's National Drought Mitigation Center is the world leader in drought preparedness and, through partnerships with our computer scientists, is becoming a research force in the development of tools for drought risk management. A UNL chemist's discovery of gold nanocages and a chemical engineer's breakthrough development of a nanoparticle-based touch sensor brought worldwide attention following their publication in *PNAS* and *Science*.

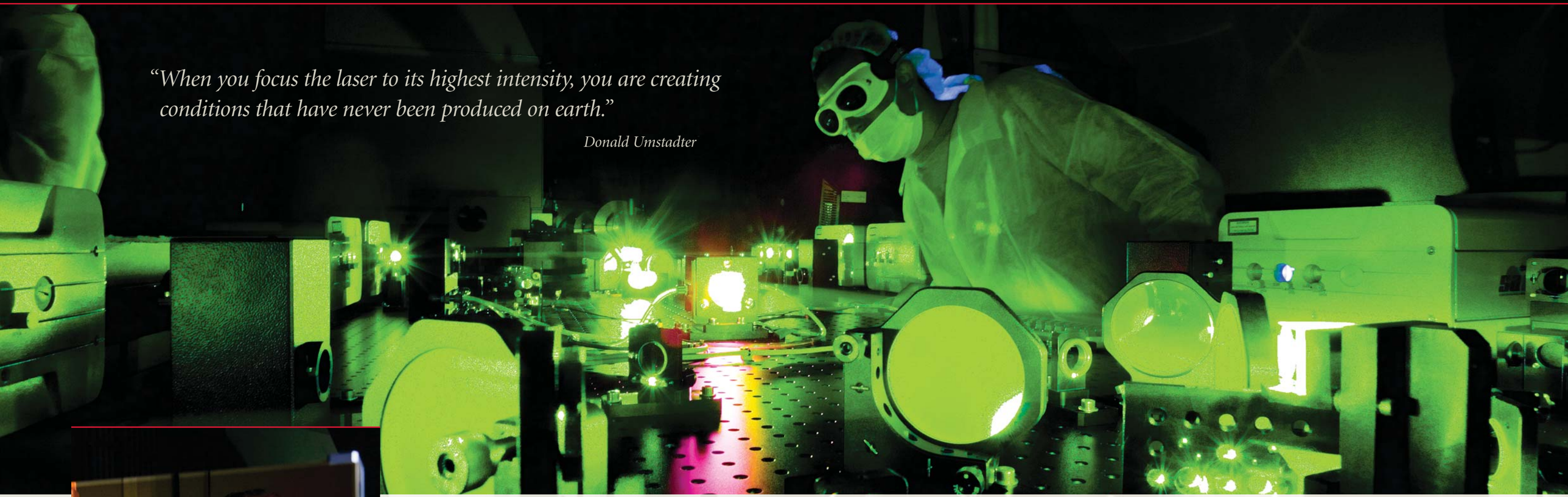
New regional, national and international partnerships are creating opportunities and yielding success. A unique partnership between UNL and the Nebraska Public Power District established the Nebraska Center for Energy Sciences Research, focused on efficiency, conservation and alternative energy research. The Four Corners Research Alliance is building on shared regional strengths among Nebraska, Iowa, Kansas and Missouri, as is our newly funded regional University Transportation Center. And the Nebraska Center for Virology has expanded its HIV/AIDS research and training programs in Zambia to a similar focus in China.

As our research programs grow, so does our commitment to technology commercialization and economic development for Nebraska. John Brasch, our new associate vice chancellor for technology development, brings to the position experience as both a former professor of marketing in the UNL College of Business Administration and a career as an entrepreneur and chief executive officer of a highly successful manufacturing business.

An increase in undergraduate and graduate student enrollments and recognition of talented students and faculty as Fulbright and Goldwater scholars and NSF CAREER and NIH K Award winners shows the promise of UNL's future.

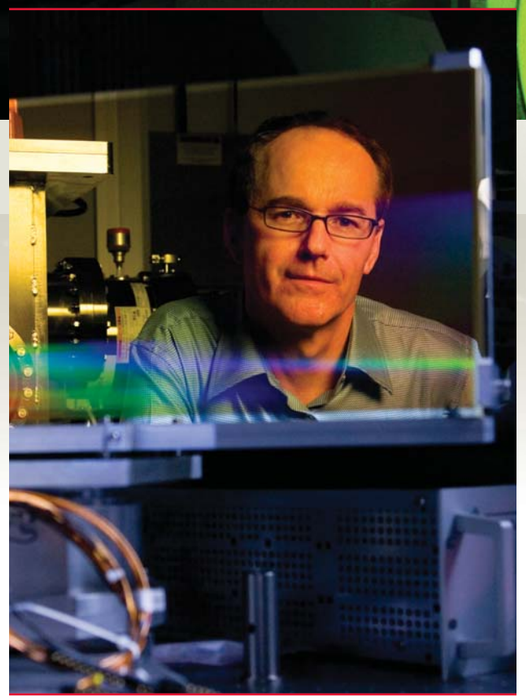
This annual report tells only a few of the successes realized by our scientists, engineers and scholars in the past year. Great things are happening at UNL and we are confident that our continuing pursuit of excellence and investment in faculty will sustain this momentum. Research truly is on the move at UNL.

Prem S. Paul
Vice Chancellor for Research & Dean of Graduate Studies



"When you focus the laser to its highest intensity, you are creating conditions that have never been produced on earth."

Donald Umstadter



Above: Donald Umstadter
Top: A technician adjusts the Diocles Laser.

EXPLORING THE FINAL FRONTIER – EXTREME LIGHT

More power than 100,000 Hoover Dams. But only for 30 femtoseconds – 30 billionths of one millionth of a second.

This is the Diocles Laser, housed in UNL's new multimillion-dollar Extreme Light Laboratory. Diocles and physicist Donald Umstadter, principal scientist and laboratory director, are putting UNL at the forefront of international high field physics and laser research.

"I believe we have one of the world's state-of-the-art laser laboratories," said Umstadter, who holds the Leland J. and Dorothy H. Olson Chair in Atomic, Molecular and Optical Physics at UNL. "We hope with our laser to reach the highest intensity ever produced by any laser in the world."

Diocles is remarkable not only because it is extremely powerful and ultra-fast, but because it is so small. The huge synchrotron accelerators conventionally used to generate intense light in the form of radiation require giant ring structures almost a mile in circumference.

Diocles is capable of producing the same level of radiation in a space the size of a living room – taking the "big" out of "big science."

Small size and 100 terawatts of power also mean Diocles can enable new technologies and applications never before possible. Diocles produces x-rays that could "see through" four-inch-thick steel to detect bombs hidden in a cargo container, hairline cracks in a jet turbine or hardware shielded with high-tech camouflage. The laser is small and inexpensive enough for hospitals to potentially use it as a proton source for cutting-edge cancer therapy, a technology for which Umstadter holds four patents.

But most interesting of all, Umstadter said, is to find out what happens when light is at its most intense.

"When you focus the laser to its highest intensity, you are creating conditions that have never been produced on earth," he said. "In fact, we can produce pressures that are greater than those at the core of the sun."

Research conducted in such extreme conditions inevitably leads to new scientific discoveries and eventually to new technologies that benefit society, Umstadter said.

Diocles' extreme light is enabling Umstadter and his team to pioneer a new research area called high field science, which involves the nonlinear optics of ultra-high intensity lasers interacting with plasmas, or ionized gas. This is both basic and applied science that has applications for advanced radiation sources and particle accelerators. Umstadter's work is funded by the National Science Foundation, the U.S. Department of Energy and the Defense Advanced Research Projects Agency.

"For us, extreme light is the final frontier," Umstadter said. "Diocles is taking us where none have gone before."

NANO DISCOVERY IS GOLDEN

Talk about your gilded cage. UNL scientists studying gold's structure at the nanoscale discovered hollow cage-like structures made of pure gold atoms.

Research by UNL chemist Xiao Cheng Zeng, graduate research assistant Satya Bulusu and colleagues revealed the first free-standing hollow cage structures composed of clusters of pure metal atoms. They are the metallic equivalent of buckyballs, the hollow carbon clusters made famous partly by their catchy name. Their findings were featured on the cover of the *Proceedings of the National Academy of Sciences* in May 2006.

Unlike carbon buckyballs, which contain 60 atoms, the golden hollow cages are composed of 15, 16, 17 or 18 atoms and can hold an atom inside. Scientists might someday be able to harness these nanocages to carry useful guest atoms for medical or industrial purposes.

Zeng's team was the first to combine quantum chemistry calculations with a powerful computerized search technique to identify previously unknown nanoscale structures and substances. With the help of UNL's PrairieFire super-computer, researchers generated many theoretical fingerprints of the gold clusters' structure.

UNL researchers worked with physicist Lai-Sheng Wang of the Pacific Northwest National Laboratory and Washington State University. Wang's team provided spectral data or fingerprints of the gold clusters, made by smashing gold with a laser beam. Clusters containing different numbers of atoms produce a unique spectral fingerprint.

By comparing spectral and theoretical fingerprints, UNL researchers identified the structures of the 15-, 16-, 17- and 18-atom gold clusters. "We were shocked when we first saw these," Zeng said. "No one expected the cage structure."

Zeng's team is studying the golden hollow cages' potential to carry nanomaterials and their prospects as catalysts to speed chemical processes.

Grants from the U.S. Department of Energy, the National Science Foundation-funded Materials Research Science and Engineering Center at UNL and the Nebraska Research Initiative support this research.

Above: Xiao Cheng Zeng (right) and graduate research assistant Satya Bulusu.
Opposite: An illustration shows a hollow nanocage made of 17 gold atoms.

"We're interested in anything that has the potential to reduce dependence on fossil fuels and foster economic opportunities."

Kenneth Cassman

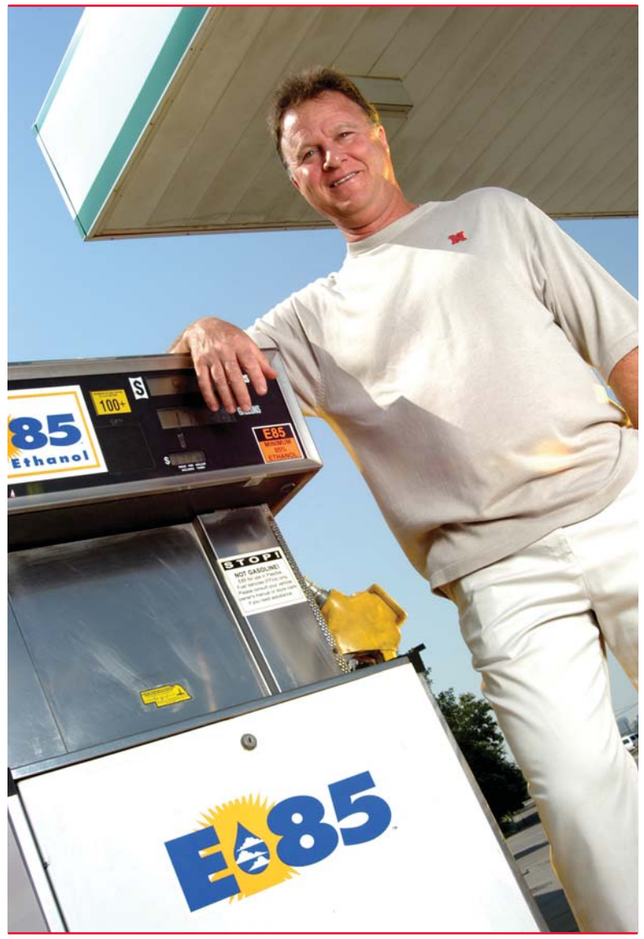
NEW CENTER FUELS ENERGY RESEARCH

Abundant water, wind, fertile land and sunlight have made Nebraska an agricultural giant. These same resources may position the state to be an energy powerhouse.

Consistent supplies of reasonably priced grain and biomass feedstocks from irrigated agriculture, a large cattle industry to use byproducts and an excellent transportation infrastructure give Nebraska the potential to become the nation's leading biofuels producer, said Kenneth Cassman, the UNL agronomist who heads the Nebraska Center for Energy Sciences Research.

The center, established in 2006 through a partnership between UNL and Nebraska Public Power District (NPPD), supports promising research to develop renewable energy and enhance energy efficiency. NPPD provided $5 million in startup funding for the center, establishing a "strategic partnership with UNL that will help address the diversity needed to produce power for future generations of Nebraskans," said Ron Asche, NPPD president and CEO.

Biofuels are just one focus for the center, Cassman said. "We're interested in anything that has the potential to reduce dependence on fossil fuels and foster economic opportunities."



Kenneth Cassman

Plentiful wind for power generation is another of Nebraska's comparative advantages in renewable energy that hold tremendous long-term economic development potential, he said.

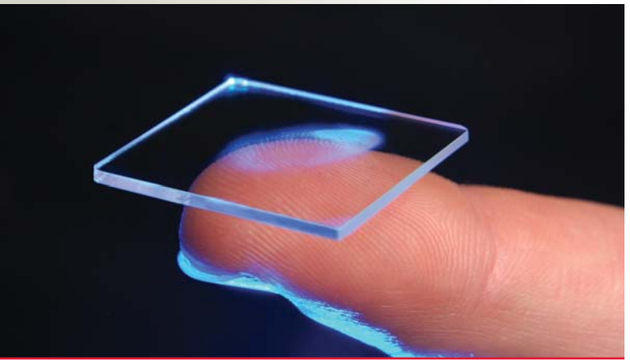
NPPD greatly expanded the state's wind power generation capacity in 2005 by opening its 36-turbine Wind Energy Facility near Ainsworth, Neb. It's the state's largest wind power operation, generating 60 megawatts of power, and offers UNL and NPPD engineers an ideal laboratory for wind power research.

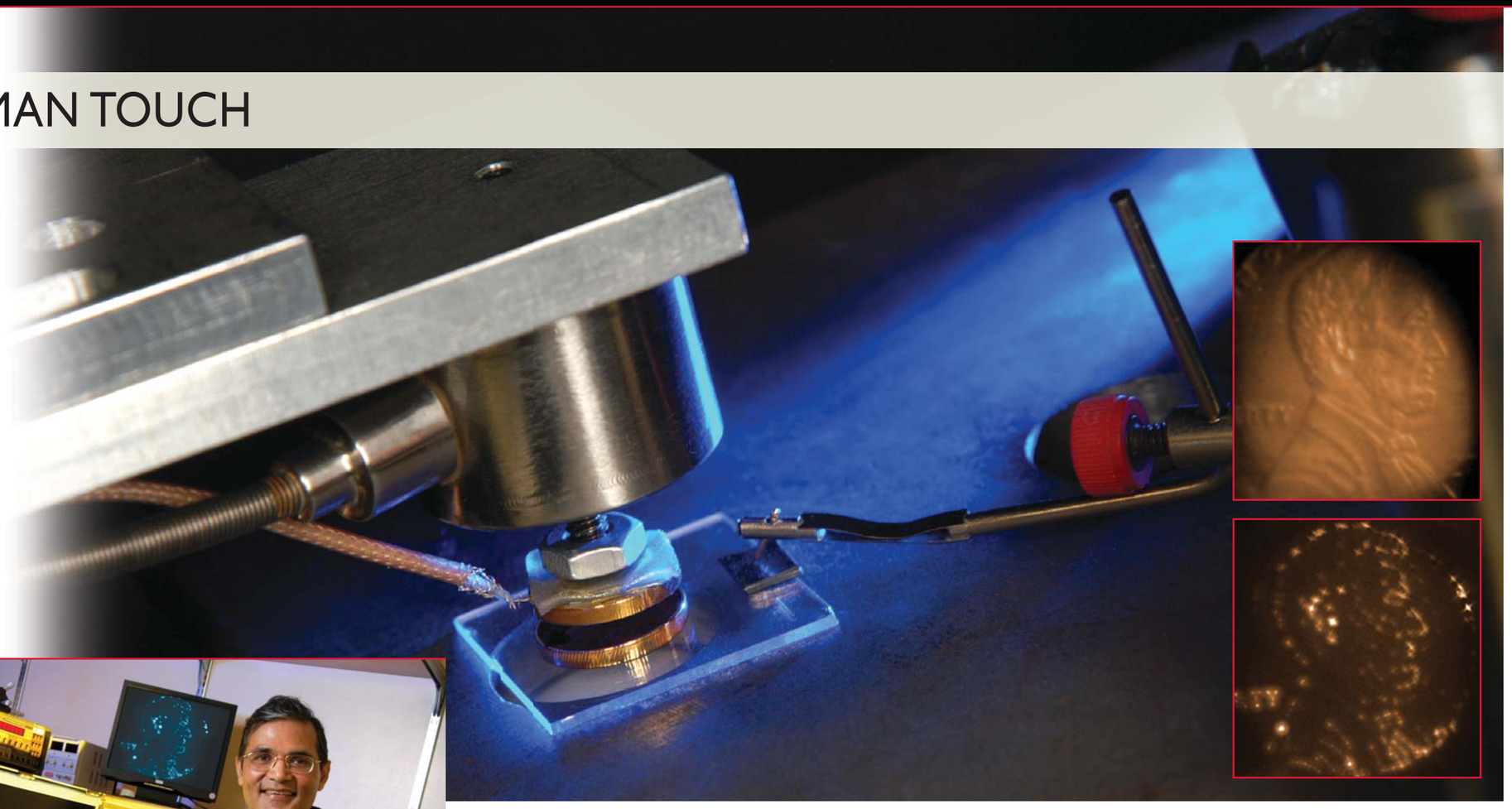
UNL's energy center will fund both new projects and diverse energy-related research under way at UNL, which includes biomass conversion and bio-refineries, advanced technologies to improve energy generation efficiency, improved irrigation efficiency, carbon sequestration, highly efficient batteries, solid oxide fuels cells and ethanol-to-hydrogen conversion.

The center encourages collaboration among individual researchers "so that the scientific and economic impact can be greater than the sum of the parts," Cassman said.

Opposite: NPPD wind turbines and a windmill near Ainsworth, Neb.

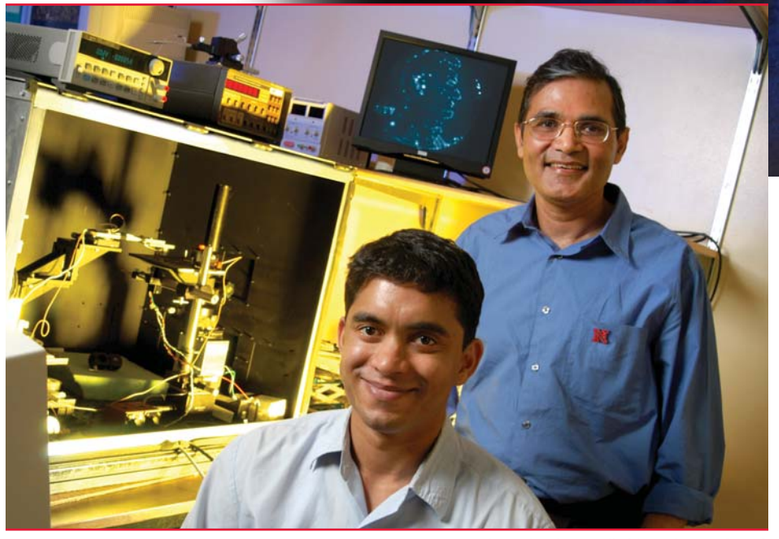
IMPARTING THE HUMAN TOUCH





A nanoparticle-based sensor with sensitivity rivaling human fingers could help surgeons more precisely remove cancerous tumors or give robots a delicate sense of touch.

UNL chemical engineers invented the thin-film sensor, which is far more sensitive than available devices. Ravi Saraf, the Lowell E. and Betty Anderson Professor of Chemical Engineering, and doctoral student Vivek Maheshwari created the thin film using layers of gold and cadmium sulfide nanoparticles separated by dielectric polymers.



Vivek Maheshwari (left) and Ravi Saraf.

The touch resolution of the human finger is 40 microns or 40 millionths of a meter, Saraf said. "Using nanoparticles, we can attain resolution of at least 20 microns, which is about 100 times better than what is out there today." The team reported its findings in *Science*.

Pressing the film against a surface pushes the nanoparticles together, creating changes in electrical current and light emissions that a digital camera can capture. For example, when the sensor is pressed against a penny, it detects creases in Abraham Lincoln's clothing.

Existing sensing devices are low-resolution, expensive and rigid, making them unsuitable for surgical applications. The UNL sensor should be significantly cheaper and offers resolution on par with a human finger. It also can be made to cover an area of one square meter or larger and can cover complex shapes.

The sensor could be used in minimally invasive surgery to let surgeons remotely "feel" tissue, tumors or gallstones. Because cancer tissue sometimes is harder than normal tissue, the sensor also could help surgeons better determine whether they've removed all cancerous cells. By pressing the sensor against a tissue sample on a glass slide, even a cluster of just a few cancer cells could be seen.

It is this cancer-fighting potential that most interests Saraf. "I am excited about this because I want to try to decipher cancer at the single-cell level."

The sensor also could be used to give robots a more humanlike sense of touch, which would be a major stride in enhancing robots' capability to perform delicate tasks.

The National Science Foundation and Office of Naval Research support this research.

Top left: The sensitivity of the UNL-developed nanoparticle-based thin-film sensor on this glass plate rivals that of human touch.

Above: The sensor detects minute details when a penny is pressed into the thin film.

TACKLING TRANSPORTATION CHALLENGES

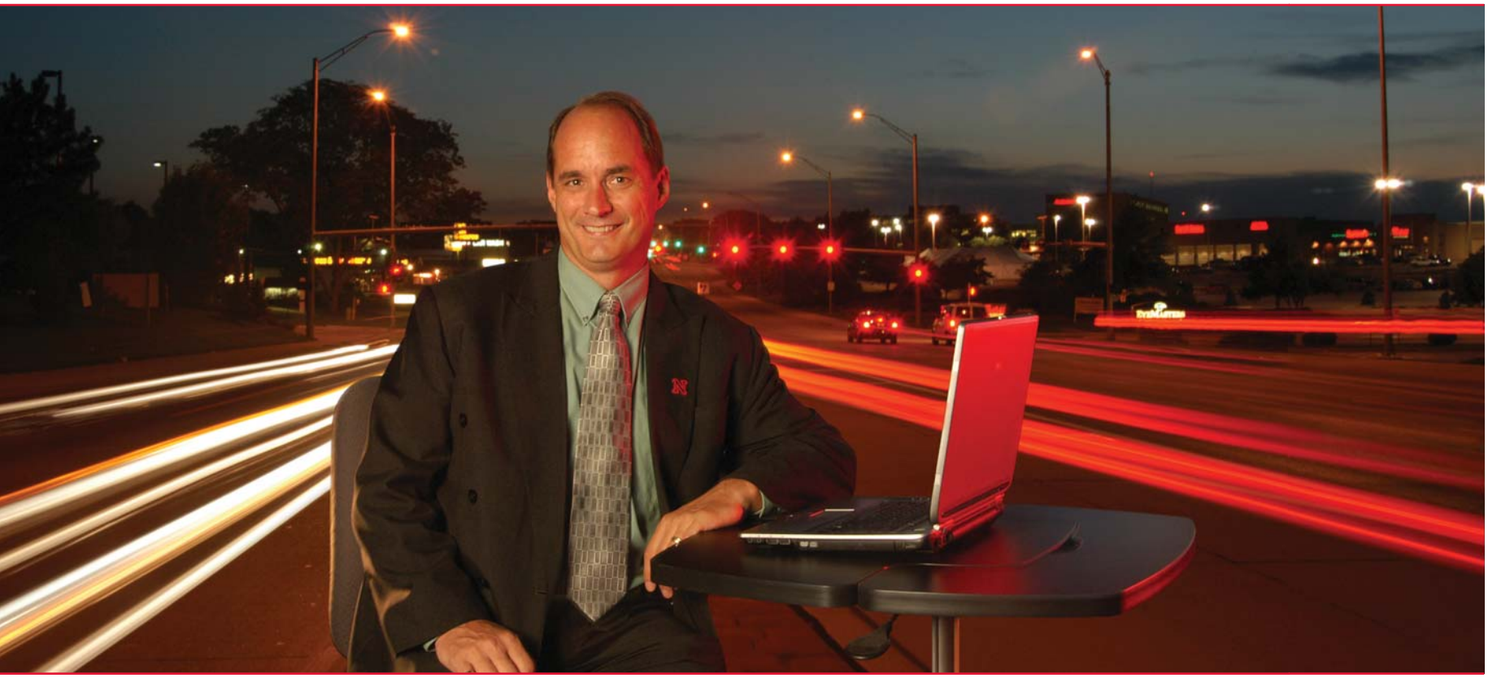
While the U.S. transportation system is among the world's best, it faces numerous challenges. UNL is expanding its research to address those problems through new partnerships and collaborations with neighboring states and universities, government agencies and industry.

UNL received a $6.2 million grant in 2006 from the U.S. Department of Transportation's Research and Innovative Technology Administration designating UNL's Mid-America Transportation Center (MATC) as a regional University Transportation Center. The UNL-based center serves Region 7, which includes Iowa, Kansas, Missouri and Nebraska. UNL's partners in MATC include Kansas State University, University of Kansas, University of Missouri-Rolla and Lincoln University of Missouri. The Nebraska Department of Roads and the Kansas and Missouri Departments of Transportation also will play a key role in the center.

Large increases in freight movements are a critical issue effecting highway and railway safety, said Laurence Rilett, UNL civil engineer and MATC director. "This is particularly true in the Midwest, which is literally at the crossroads of the nation's transportation system." For example, improving railway crossings is an important safety issue in many Nebraska towns, which may have up to 150 trains passing through daily.

MATC's research will center on improving safety and minimizing the risk associated with this increased freight congestion, Rilett said. Safety research related to rural transportation will be a particular focus. Key rural safety research areas include traffic control, animal crashes, safer at-grade railway crossings and work zones, and the development of more effective and economical roadside crash barriers.

The University Transportation Center designation is an outgrowth of efforts to integrate transportation research, education and outreach at UNL and three other University of Nebraska campuses. The UNL-based Nebraska Transportation Center, established in 2006, brings together the transportation expertise of the university, industry and government, including the Nebraska Department of Roads, which provided a large share of the initial funding.



Left: Laurence Rilett

CONCRETE RESULTS

Maher Tadros' pioneering research is transforming bridges and other structures in places as diverse as Nebraska, India and Australia. Expanding the strength, versatility and utility of concrete has earned the UNL civil engineering professor an international reputation as a bridge engineering expert.

Safety and economics are key considerations in bridge design; Tadros' inventions address both. He developed high-performance concrete that is nearly as strong as steel and can be used in bridges and buildings. The concrete contains tiny steel fibers like those used in steel-belted tires, making it strong enough even to withstand bombs.

Tadros is best known for his NU I-Girder, which allows longer bridge spans between supports using shallower structural depths. Several states and foreign countries now use the girder; researchers are modifying the design for use in other structures.

Another innovation, the Inverted Tee System, uses pre-fabricated parts assembled on site, minimizing the cost of short bridges. Tadros' NUDECK, a prefabricated system patented by UNL, also speeds construction and creates longer-lasting bridge decks. Yet another invention, the NUTie, made of fiber-reinforced plastic, is used to construct stronger, more energy-efficient building walls.

Tadros says a strong partnership with the Nebraska Department of Roads enables UNL and the state to implement research innovations that routinely garner international attention. Recently, in rural Ravenna, Neb., this team built the nation's first post-tensioned, tied-arch bridge, a UNL-patented design that uses steel tubes filled with concrete and reinforced with steel tendons to make the bridge less prone to fracture. Tadros is working on an Omaha overpass that he expects will earn national attention. It will be built off-site in two halves, then rolled into place over a weekend. "The traveling public will see very little (road) closure," he said.

Engineers may watch Tadros closely but his success lies in how little the public notices his work – on the road or in the budget.

The Nebraska Department of Roads, National Cooperative Highway Research Program and industry are among funders for Tadros' research at the university's Peter Kiewit Institute in Omaha.

Above: Babrak Niazi of the Nebraska Department of Roads (left) and Maher Tadros in front of an innovative new bridge.

DUNES DIVULGE MEGA-DROUGHT CLUES

Nebraska's Sandhills, a region of rolling, prairie grass-covered sand dunes and wetlands, was once a swirling desert. UNL scientists determined the weather conditions that existed the last time the dunes were on the move about a thousand years ago. If these conditions return, they could again turn the verdant Sandhills, the Western Hemisphere's largest sand dune area, into a wasteland.

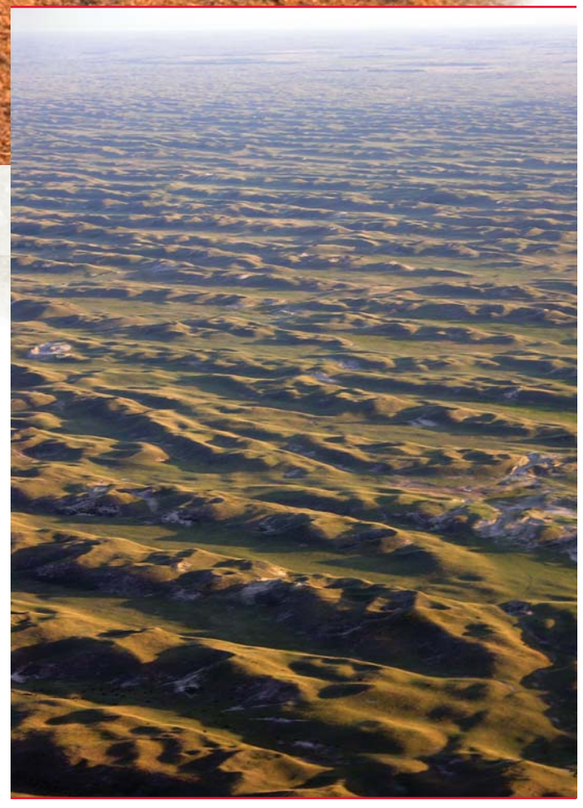
Using dune core samples and a computer program that determines how dunes form under different wind patterns, researchers identified a historically unprecedented, large-scale wind shift that cut off moisture to the region during the growing season. This shift created a mega-drought far worse than the Dust Bowl in much of the western U.S. during the Medieval Warm Period, 800 to 1,000 years ago.

Although drought regularly occurs across the Great Plains, modern droughts haven't been severe enough to destabilize the dunes.

"We think we know drought, but that's probably wrong," said David Loope, a UNL geoscientist. "It was a whole different scene in medieval time than it was in the 1930s and '50s."

Researchers don't know what caused the wind shift, but knowing it happened in the past indicates it can happen again. "That these conditions existed only a thousand years ago is sobering," he said.

This research, published in *Science,* is part of UNL's larger Sand Hills Biocomplexity Project, funded by the National Science Foundation, to understand the region's hydrology, ecology and geology.



Above: Grass-covered dunes of the eastern Sandhills provide clues to a medieval mega-drought.

Top: Drought-ravaged pastures in southwest Nebraska.

NEW DROUGHT TOOLS AID TOUGH DECISIONS

New Web-based technologies being developed at UNL are giving farmers and ranchers better tools to contend with drought.

A partnership between the UNL's National Drought Mitigation Center and Department of Computer Science and Engineering combines the expertise of climatologists and computer scientists to bring cutting-edge computer technologies to producers' decision-making. The U.S. Department of Agriculture's Risk Management Agency provided three-year partnership agreements totaling more than $7 million for these UNL-based projects in 2005.

UNL computer scientists have created the National Agricultural Decision Support System (http://nadss.unl.edu) to host a variety of weather data and tools that help producers assess drought and other crop-production risks and aid their decision-making.

"We're working together to identify the needs and then tailor the tools for producers," said Steve Goddard, an associate professor of computer science and director of the Laboratory for Advanced Research Computing.

The National Drought Mitigation Center (http://drought.unl.edu) also has a variety of online decision-support tools in various development stages, including:

- Drought Impact Reporter, which allows users to enter information about drought's specific impacts across the United States.
- Vegetation Drought Response Index, which uses satellite and climate data for a square-mile by square-mile analysis of drought conditions.
- Continued improvements in the U.S. Drought Monitor, a weekly national map that the drought center produces in partnership with USDA and the National Oceanic and Atmospheric Administration.
- Vegetation Outlook, which will provide projections of general vegetation conditions several weeks in advance.
- Drought Risk Atlas, which will provide users a comprehensive picture of the history, frequency, intensity, duration and trends of droughts over the past century.

James Alfano

UNRAVELING IMMUNE SYSTEM INTRICACIES

Despite their differences, plants and animals share some of the same molecular components for defending themselves against outside invaders. That's why the National Institutes of Health is funding UNL plant pathologist James Alfano's innovative work.

Alfano discovered a protein – HopU1 – that disrupts a plant's immune system when the pathogen *Pseudomonas syringae* injects it into the plant. This disruption helps the disease-causing bacterium infect its host. HopU1 interests plant and animal researchers because it is a type of enzymatic protein – an ADP-ribosyltransferase – found in several animal pathogens, such as those that cause diphtheria and cholera. Alfano was the first to discover it in a plant pathogen.

"It gives us a whole new avenue to pursue in understanding plant-innate immunity," said Alfano, a member of UNL's Plant Science Initiative.

To infect a plant, *Pseudomonas syringae* and similar pathogens inject up to 30 proteins using a microscopic syringe-like process called a Type III protein injection system.

Once inside the plant, the toxic protein mix acts like a burglar, cutting wires to a home's alarm system, disabling the defense system from calling for reinforcements and allowing the intruders to enter unimpeded.

Now Alfano is studying which plant components HopU1 targets. That's key to learning which components are important to plant immunity. He's already made a surprising discovery: HopU1 modifies RNA-binding molecules found in plants and animals but not previously known to be part of the immune system.

Alfano uses *Arabidopsis,* a well-studied plant, as a model. As his research increases understanding of plant immunity, scientists may be able to genetically modify crop plants to better defend themselves against disease. Because he also found HopU1 affects human proteins, he's studying its effect on immunity in human cells. This work should identify shared components of immune systems in plants and animals, and may one day lead to breakthroughs in fighting human diseases.

CAREER/K Awards

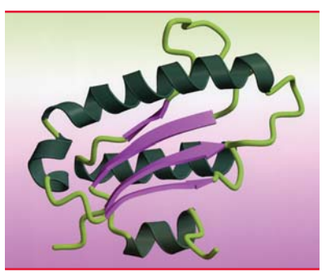
Several UNL faculty earned National Science Foundation or National Institutes of Health career development awards in fiscal year 2005-06. NSF's CAREER and NIH's K Award programs provide funding to help exceptional faculty develop as outstanding teacher-scholars and garner independent research funding.
New UNL recipients are:

NSF CAREER Awards
Christian Binek, Physics and Astronomy
Kenneth Bloom, Physics and Astronomy
Aaron Dominguez, Physics and Astronomy
Mustafa Gursoy, Electrical Engineering

NIH K Award
Marc Kiviniemi, Psychology

SOLVING EVOLUTIONARY MYSTERIES

When UNL chemist Robert Powers set out to understand protein AF2095, he unexpectedly discovered an important clue to a long-standing evolutionary mystery.



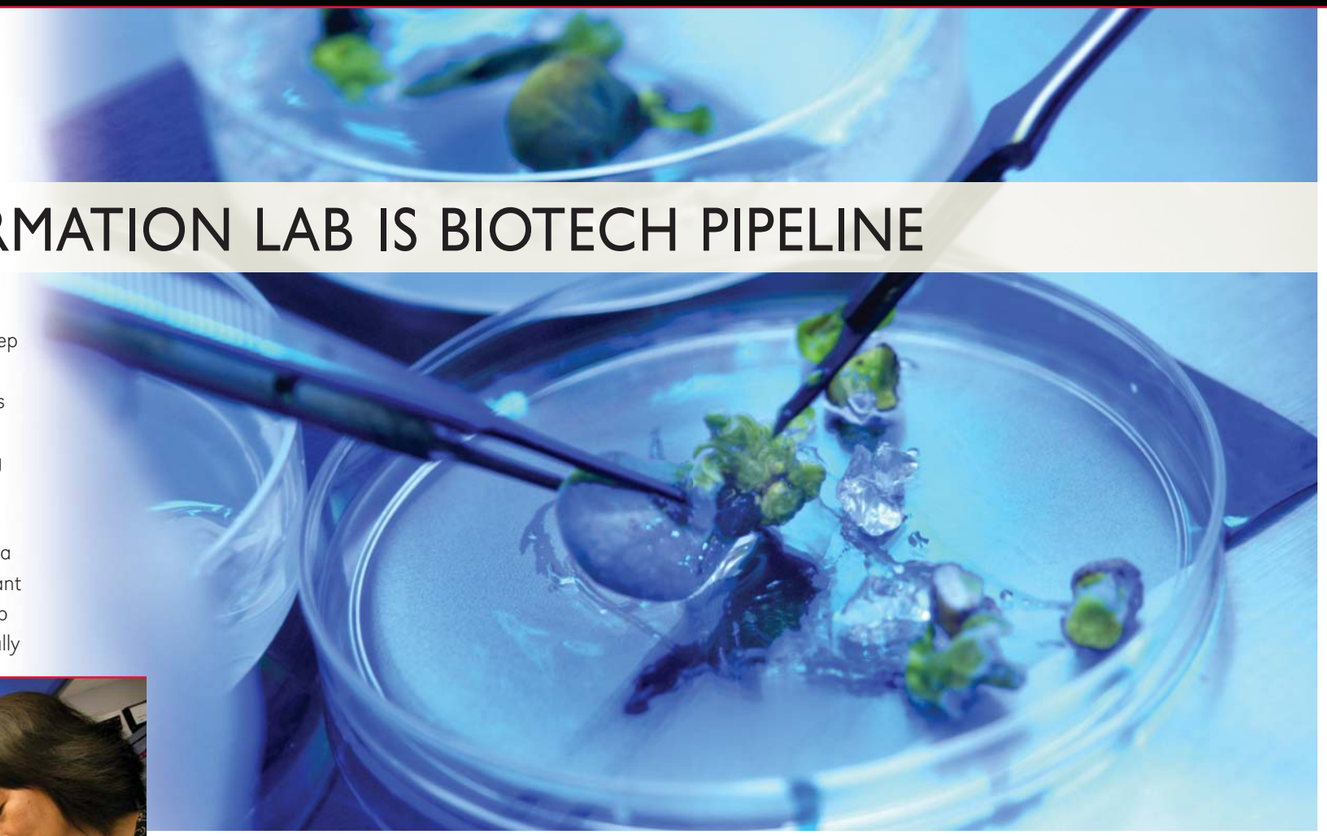
Scientists believe that mitochondria, cellular structures vital to humans, animals and many other organisms, evolved when one type of single-celled organism merged into another. The exact nature of that evolutionary process remains unknown. Powers and colleagues from several universities found a link between these two distinct organisms — and to humans.

Using nuclear magnetic resonance, Powers and colleagues determined the 3-D structure of AF2095, a protein found in an archaea, a class of single-cell organisms that thrives in relatively high temperatures. Scientists hoped the structure would provide clues to its function. They found AF2095's structure matched another protein discovered in humans and therefore shares the same critical function: recycling tRNA.

Bacteria perform that function using an entirely different protein so scientists know the function evolved separately in archaea and bacteria. Both proteins also are found in human cells, one in the cytoplasm and the other in the mitochondria, providing valuable clues to their origins and our understanding of early evolution. The discovery was featured on the cover of the November 2005 issue of *Protein Science.*

Nebraska Tobacco Settlement Biomedical Research funds, the National Institutes of Health, National Science Foundation and U.S. Department of Energy helped fund this work.

PLANT TRANSFORMATION LAB IS BIOTECH PIPELINE



Tiny genetically enhanced plants in growth medium.

Identifying potentially useful genes is just the first step toward creating enhanced plants for the real world. A unique research resource at UNL simplifies and speeds the often complex journey from discovery in the lab to the field and potential commercialization for promising genetically modified plants.

The Plant Transformation Core Research Facility offers a complete "agricultural biotechnology pipeline," said plant scientist Tom Clemente, facility manager. It's a one-stop shop for researchers and companies seeking to genetically engineer plants with improved or specialized characteristics, such as drought or insect resistance, or for scientists probing a specific plant gene's role.

Lab manager Shirley Sato (foreground) and Kwang-Hoon Oh in UNL's Plant Transformation Core Research Facility.

Clemente's team is known for its expertise in successfully inserting or altering plant genes. While most facilities specialize in transforming a few plants, UNL's lab can genetically alter any important Midwest crop plant and several plants used extensively for research. The team doesn't stop with successfully inserting the gene.

Researchers literally take genetically modified plants from the lab to the processing plant. They grow and test plants in the greenhouse and later in plots dedicated to field testing transgenic plants before processing a harvested crop to ensure it delivers desired qualities or components.

As the only university with all of the components to develop, field test and process genetically engineered plants and products on such a large scale, UNL offers an indispensable resource for researchers and companies nationwide, Clemente said.

For example, when Monsanto Co. launches a new herbicide-resistant soybean in a few years, it will in part be thanks to the facility's capabilities. UNL biochemist Don Weeks discovered a gene that helps soybeans and other broadleaf crops withstand spraying with dicamba, a widely used broadleaf herbicide. Clemente's team successfully inserted the gene in soybean DNA, then tested the soybeans in the greenhouse and the field. This process would have taken far longer without the facility. UNL patented Weeks' discoveries, which Monsanto is developing under a university licensing agreement.

The processing facility – the latest addition to UNL's resources – completes the research pipeline. It allows researchers to develop and test new products from genetically enhanced plants. For example, Clemente and a colleague are processing and testing oil from a soybean they developed especially for biodiesel production.

The Nebraska Research Initiative, Nebraska Soybean Board, North Central Soybean Board and United Soybean Board are among the organizations funding projects in the facility. The team also is training plant breeders to maintain regulated, genetically engineered plants in the field through a $600,000 USDA grant.

ORGANIC FARMING RESEARCH EXPANDING

Organic farming is among the fastest growing segments of U.S. agriculture. A new initiative is expanding UNL's organic farming research and education efforts to help growers make the most of this expanding market.

With funding from a four-year $750,000 grant from USDA's Cooperative State Research, Education and Extension Service, scientists in the university's Institute of Agriculture and Natural Resources are laying the foundation for long-term organic farming research. Goals include establishing UNL's first certified organic research fields, launching focused crop production research, working closely with the state's organic farmers and incorporating organic farming concepts into UNL's research, teaching and extension missions.

Establishing 20- to 40-acre certified research plots at four university research farms across the state is a key component. Certification takes three years. Devoting land to organic research around the state means each site can focus on locally important production issues while the network will provide statewide results, said Charles Shapiro, a soil scientist at the Northeast Research and Extension Center and one of seven project co-leaders.

A UNL Extension educator is coordinating the project and planning how to share findings and organic concepts with farmers and students. Organic growers are advising on the project and researchers are conducting studies on cooperating certified organic farms. The new infrastructure will create opportunities for broader organic farming research at UNL.

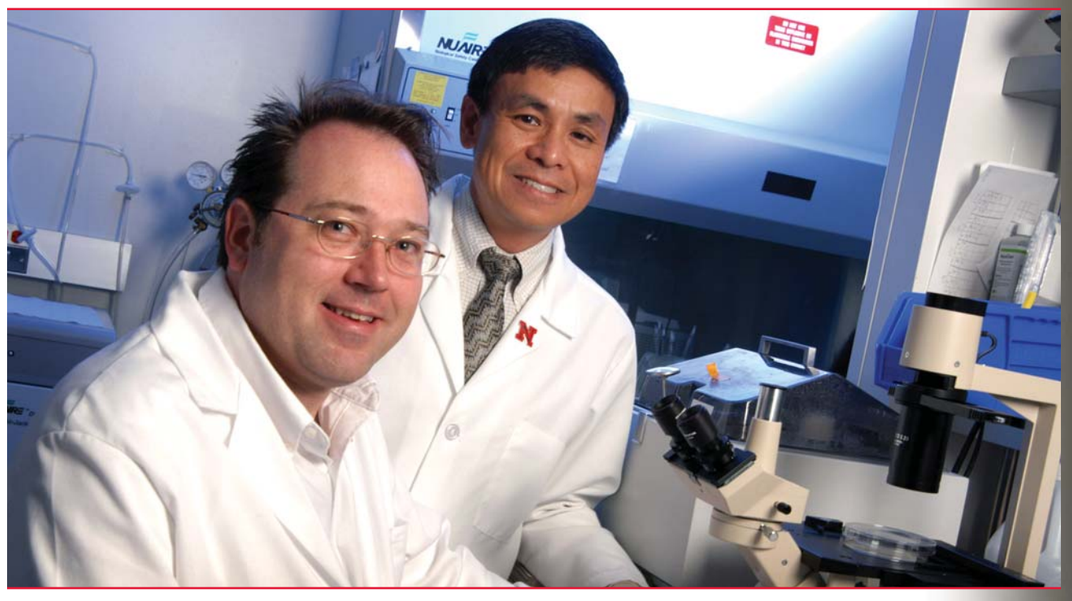
TRAINING INTERNATIONAL HIV/AIDS RESEARCHERS

The African nation of Zambia is ground zero in the HIV/AIDS pandemic. Statistics tell the tragic story: one in four Zambian mothers is infected with HIV; one in every six adults is living with HIV; and 710,000 children are AIDS orphans.

For a poor and underdeveloped nation like Zambia, where about two-thirds of the population lives on less than a dollar a day, assistance from other nations is the only way to fight AIDS. But Charles Wood, UNL molecular virologist and director of the Nebraska Center for Virology, is offering assistance that empowers Zambians to fight the battle themselves.

With funding from the National Institutes of Health Fogarty International Program, Wood provides programs that help Zambian researchers understand how HIV and AIDS-associated cancer viruses cause disease and train them to detect and prevent disease transmission.

Begun in 2000 and renewed by NIH with a $2.1 million award in 2006, the program brings Zambia researchers to UNL, the University of Miami and the University of Alabama at Birmingham for training and provides in-country workshops. Twenty-six Zambian fellows have completed training and returned to Zambia, where they hold research and clinical positions that directly influence their country's AIDS research capabilities.



Virologists Peter Angeletti (left) and Charles Wood in a Nebraska Center for Virology lab. Wood heads a program to train Zambian and Chinese scientists and both scientists conduct research in Zambia as well as the U.S.

In 2003 Wood expanded his Fogarty training programs to China, where HIV is a growing threat and 600,000 people are infected. The virus is spreading rapidly, causing concern that China, with its high population density, might be the next locus of the HIV pandemic. Wood's Fogarty program with Nankai University emphasizes training in advanced HIV detection and monitoring methods, clinical disease management and behavioral interventions.

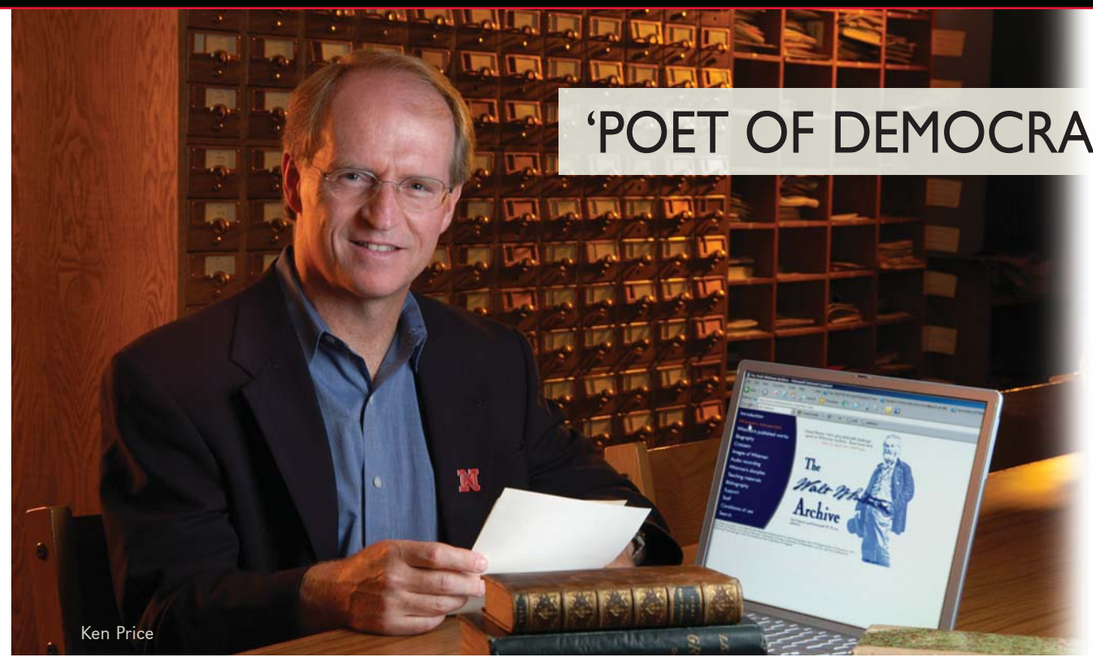
Expanding Partnerships with Zambia, China

The Fogarty International Training Programs provide a base from which UNL is launching additional collaborations with the University of Zambia and Nankai University in China.

In June 2005 UNL Chancellor Harvey Perlman, Vice Chancellor for Research Prem Paul and Charles Wood traveled to Zambia to meet with University of Zambia (UNZA) and government officials and sign a memorandum of understanding between the two universities. In June 2006 a UNZA delegation visited UNL to learn about research programs in education, agriculture, biomedical research and other areas.

A trip to China in July 2006 by Perlman, Paul and Wood included visits to Zhezang University, Fudan University, the China Center for Disease Control and the newly opened U.S. National Science Foundation office. UNL signed a memorandum of understanding with Nankai University to develop collaborative programs in life sciences research, technology transfer and other areas of mutual interest.

Above: UNL representatives Charles Wood, Vice Chancellor for Research Prem Paul and Chancellor Harvey Perlman with William Chang, director of the Beijing office of the National Science Foundation and science attaché for the U.S. Embassy in China, at the newly opened NSF office in China.



Ken Price

‘POET OF DEMOCRACY’ GOES DIGITAL

UNL English professor Ken Price calls Walt Whitman “the poet of democracy.” So it seems fitting that digital research by Price and others is making this quintessentially American writer’s works freely available to anyone with Internet access.

UNL scholars and librarians are collaborating with colleagues at other universities to create a comprehensive online archive that is receiving international acclaim. The Walt Whitman Archive (www.whitmanarchive.org) is an electronic research and teaching tool that makes the poet’s huge body of work easily accessible.

“Whether you’re in Montana or the Ukraine, you can pull up the original manuscript images and start making discoveries for yourself,” said Price, Hillegass Chair of 19th-century American Literature and archive co-director. The archive is primarily for scholars but attracts students, teachers and Whitman fans worldwide.

Whitman’s international stature, vast body of work, evolving style and obsession with rewriting fit well with the dynamic nature of an electronic archive, which can be easily expanded or updated. Compiling Whitman’s diverse writings in one spot allows scholars to examine his work as never before.

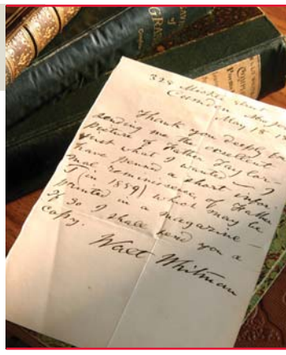
Tracking down manuscripts is challenging. Whitman’s roughly 80,000 known manuscripts are housed at more than 70 institutions. More than 30 sites house his poetry manuscripts alone, making comprehensive scholarly research nearly impossible before the archive.

The team has collected and is now editing copies of original poetry manuscripts from all 30-plus sites and has developed the first integrated guide to Whitman’s poetry manuscripts. This guide earned the C.F.W. Coker Award from the Society of American Archivists in 2006. Price led the project along with Katherine Walter, chair of the UNL Libraries’ Digital Initiatives and Special Collections, and archive co-director Ed Folsom of the University of Iowa. Grants from the National Endowment for the Humanities and Institute of Museum and Library Services support this work.

In fall 2005, UNL received a $500,000 NEH “We the People” challenge grant for a permanent endowment to support the archive’s ongoing scholarship. UNL must raise $1.5 million to receive the full amount. Price believes this is the first American literary project to receive a “We the People” grant, which focuses on the nation’s founding and principles of democracy. It’s a good fit.

“Whitman is the poet of democracy,” he said. “He’s woven into the fabric of everything it means to be an American: who we have been, who we are and who we might be in the future.”

Center Enhances Humanities Research



UNL’s Center for Digital Research in the Humanities is expanding and bringing international attention to digital scholarship.

This joint initiative of the UNL Libraries and College of Arts and Sciences, co-directed by Ken Price and Katherine Walter, emphasizes interdisciplinary research. It works with scholars to develop digital content and tools and offers workshops and fellowships on digital scholarship. The center has more than 35 active projects, including the Journals of the Lewis and Clark Expedition, Willa Cather Archive and Walt Whitman Archive.

“We’ve gone from hosting a few projects to taking bold steps to achieve leadership in this field,” Price said.

GIS ATLAS REVEALS RAILROAD’S INSTRUMENTAL ROLE

Using the power of modern digital technology, UNL historian William Thomas is gaining a deeper understanding of the effect an earlier, equally transformative technology – railroads – had on 19th-century America.

This project will help Thomas and others identify social consequences related to the railroad, such as demographic and environmental changes, immigration patterns, women’s political involvement in the West and African-American migration patterns.

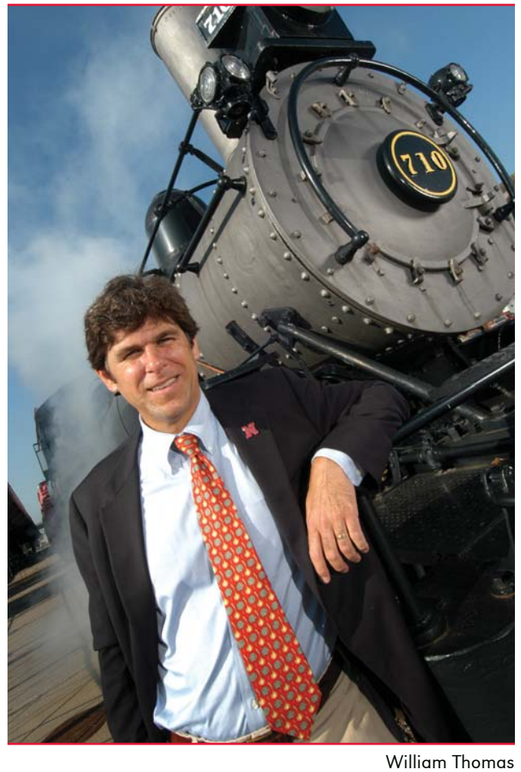
To do that, Thomas is creating a Geographic Information System, or GIS-based digital atlas that tracks the growth of the entire railroad network across space and time.

To this GIS atlas, he is linking primary historical documents gleaned from other scholarly work and historical archives. Once developed, researchers can watch the railroad’s progression over time on their computers and search for documents linked to a particular place or time for further investigation.

These powerful linking and search tools are helping researchers identify otherwise obscure connections. “Without this technology, it would be impossible to try to have at your fingertips a full, multidimensional atlas of a subject like railroads and its instrumental role in the development of modern America,” said Thomas, the John and Catherine Angle Chair in the Humanities.

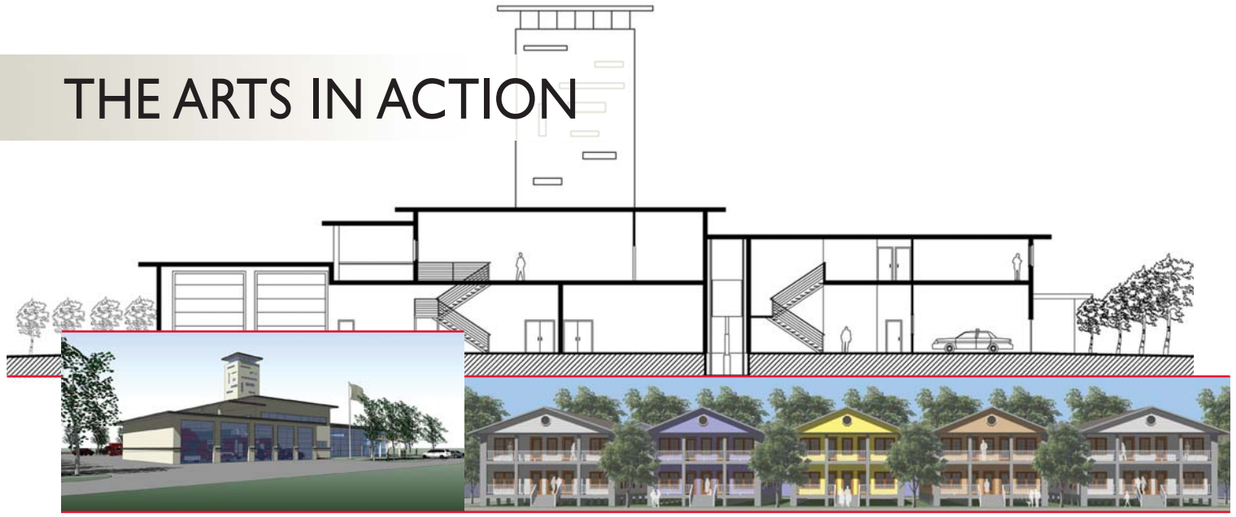
Before joining UNL in 2005, Thomas headed the Virginia Center for Digital History at the University of Virginia. There he created a digital collection focusing on Virginia’s Eastern Shore, which he uses to understand the railroad’s contribution to the region’s agricultural growth decades later. Now Thomas is building a digital collection of the Great Plains.

“Trying to understand the transformation the railroad brings to the Great Plains and document it as a system with all of its social effects, as opposed to a kind of corporate history, is challenging,” he said, but digital technology makes it possible. Graduate and undergraduate students are heavily involved in this UNL Center for Digital Research in the Humanities project.



William Thomas

THE ARTS IN ACTION



Architecture student designs for New Orleans.

Designing for New Orleans

After Hurricane Katrina devastated the Gulf Coast, UNL Architecture Dean Wayne Drummond got a call for help from his friend Cliff James, director of the Urban Design Research Center in New Orleans. That call set in motion a whirlwind of research and design for Drummond, architecture professor Jim Potter and 27 students.

Students in Drummond's design studio course toured New Orleans, assessing the extensively damaged Jubilee City neighborhood near the Superdome. Students designed public and commercial buildings and multifamily housing, which they compiled into a master plan for the area. Potter's students designed single-family housing prototypes that matched New Orleans' culture and environment.

"This isn't just a class project, it's an amazing lesson in the sociology of our country," Drummond said. A book and CD containing the plan provides a reference for agencies and decision makers working to rebuild the city.

Exploring Platte Water Issues

In Nebraska, water and the Platte River are inexorably linked. To explore critical issues of water supplies, quality and conservation, 19 students in the UNL College of Journalism and Mass Communications teamed with the Lincoln Journal Star to produce "Platte River Odyssey," an in-depth report on Nebraska's Platte River. Lecturer Carolyn Johnsen and her science writing class led the project.

Their stories ran as a series in the Journal Star and were published as a magazine available through the college. They provide a comprehensive look at the Platte's history as well as scientific, political, environmental and legal issues.

"This report will provide a lasting resource to help readers see the Platte River as more than an attractive feature in the landscape," Johnsen wrote in the report's introduction. "'Platte River Odyssey' will provide solid background for a dynamic story that will continue to develop."

The goal of the science writing program, funded partly by the Office of Research, is to improve science reporting and public understanding of science.

Book Celebrates Sheldon Sculptures

UNL's Sheldon Memorial Art Gallery and Sculpture Garden houses one of the nation's finest collections of 20th-century American sculpture.

Karen Janovy

Sculpture from the Sheldon Memorial Art Gallery, published in 2005 by the University of Nebraska Press, celebrates this remarkable collection. Compiled and edited over 14 years, the book includes an exhaustive study of the history of sculpture and essays on 90 of the 350 works in the Sheldon's collection, including pieces by Rodin, Calder, Duchamp and Moore. Color photographs by John Spence accompany the essays.

"The publication documents not only the Sheldon's collection but also the uniqueness of the history of the collection," said Karen O. Janovy, Sheldon's education curator and the book's editor. "The contributing essayists are all experts within the field of 20th-century art. Publishing this type of scholarship is an important mission of the museum."

The project, conceived of as a companion piece to a 1988 publication on the Sheldon's painting collection, was funded by the National Endowment for the Arts, Nebraska Art Association, Cooper Foundation, Elizabeth Firestone Graham Foundation, Institute of Museum and Library Services, Paul Klein Art Works, Henry Luce Foundation and University of Nebraska Foundation.

Benefits of Smaller Keyboards

Pianist Brenda Wristen, a UNL assistant professor of music, has small hands. For years she noticed a tendency toward occupational injuries among small-handed pianists.

With funding from the UNL Research Council and the Hixson-Lied Foundation, Wristen and Susan Hallbeck, an associate professor of industrial and management systems engineering, collaborated to study the ergonomics of seven-eighths size keyboards. They monitored 24 pianists and concluded the smaller keyboard dramatically improves their comfort and musicianship.

Wristen would like to see a dual standard developed to make seven-eighths keyboards available at concert halls worldwide. She also hopes to establish a center at UNL for the study, prevention and treatment of musicians' health disorders.

SMOKING'S IMPACT ON BABIES' BEHAVIOR

Kimberly Andrews Espy uses sophisticated sensors to measure brain function in babies in her research to understand how tobacco exposure before birth affects behavior.

No one wants a cranky, irritable baby. Yet early results in ongoing UNL research suggest maternal smoking during pregnancy may contribute to such behaviors.

Neuroscientist and Associate Vice Chancellor for Research Kimberly Andrews Espy is in the midst of one of the first studies examining whether a mother's smoking during pregnancy influences her baby's behavior. Links between maternal smoking and low birth weight are well documented but scientists know little about behavioral impacts. This five-year $2.3 million study funded by the National Institute on Drug Abuse eventually will involve at least 400 mothers and their babies from Illinois and Nebraska. Half the women smoked during pregnancy, half didn't.

Researchers are focusing on babies' early attention and stress reaction skills. They are measuring neonatal development of these skills to pinpoint how tobacco influences behavior. While many more moms and babies will be tested, Espy already sees some trends.

"We are finding the babies whose moms smoked are more irritable and reactive," she said. Infants exposed to tobacco before birth tend to overreact to stimuli, such as rattles or bells, and cry more frequently.

"They just tend to be more reactive to stimuli and that seems to be directly related to how much mom smoked during pregnancy."

While differences aren't huge, babies exposed to tobacco could be a little harder to care for, Espy said. More significantly, these behaviors might contribute to later problems for some children. She stressed that tobacco exposure is one of many factors – from genetics to parenting – that influence behavior but might tip the balance for some children.

Researchers test women during pregnancy and babies at birth to determine tobacco exposure. During the baby's first month, researchers assess their behavior for clues to what's happening in the brain. At six months, sophisticated sensors measure brain function as a baby does specific tasks. "It really gives you a great sense of how tobacco exposure is affecting brain function," Espy said. Researchers also are conducting molecular genetic analyses to learn whether tobacco exposure increases the risk for children with genes related to Attention Deficit Hyperactivity Disorder.

"Children's development is complicated so you have to collect lots of data to really get at the role of a single factor like tobacco," she said. Statistical analysis helps predict average behavioral development and tease out differences attributable specifically to tobacco exposure.

Findings could lead to interventions to help kids who have behavior problems in school and provide information to enable women to make better-informed decisions about smoking during pregnancy.

HORSES A POWERFUL PREVENTION TOOL

Horses are deeply woven into the Omaha people's culture and history. That strong cultural link is at the heart of a partnership between the Omaha Tribe of Nebraska and UNL researchers. Together, they're developing an alcohol and drug prevention program for at-risk 10- to 13-year-olds on the Omaha reservation at Macy, Neb., with a three-year, $432,000 grant from the National Institute for Drug Abuse.

Graduate assistant Anitra Mallory

The result is Shonga Ska, or Sacred Horse Society, a community-driven prevention program that combines proven horse-assisted therapy techniques with Omaha traditions and culture.

"Our research shows how much family and cultural involvement are protective factors for these kids," said Les Whitbeck, a UNL sociologist who works with Native Americans on substance-abuse prevention programs.

Whitbeck and graduate student Anitra Mallory said community involvement is essential to success. A member of the Southern Ponca Tribe of Oklahoma, Mallory worked in youth services at Macy before coming to UNL. She teamed with the tribe on the eight-week pilot project for 12 at-risk Omaha youth in summer 2006.

Separate sessions for girls and boys include cultural discussions, classroom activities and information on avoiding drugs and alcohol as well as working with horses. Horses proved a powerful tool for teaching responsibility, self-respect, confidence, communication and cultural pride.

"The kids really responded to every activity with the horses," Mallory said. She didn't grow up around horses but completed three equine therapy certification courses before working on this project. "To see them coming together and growing like that is just amazing."

The program addresses almost every risk factor for kids using drugs, Whitbeck said. "They have a peer group, confidence and refusal skills. If you're Shonga Ska, you don't drink."

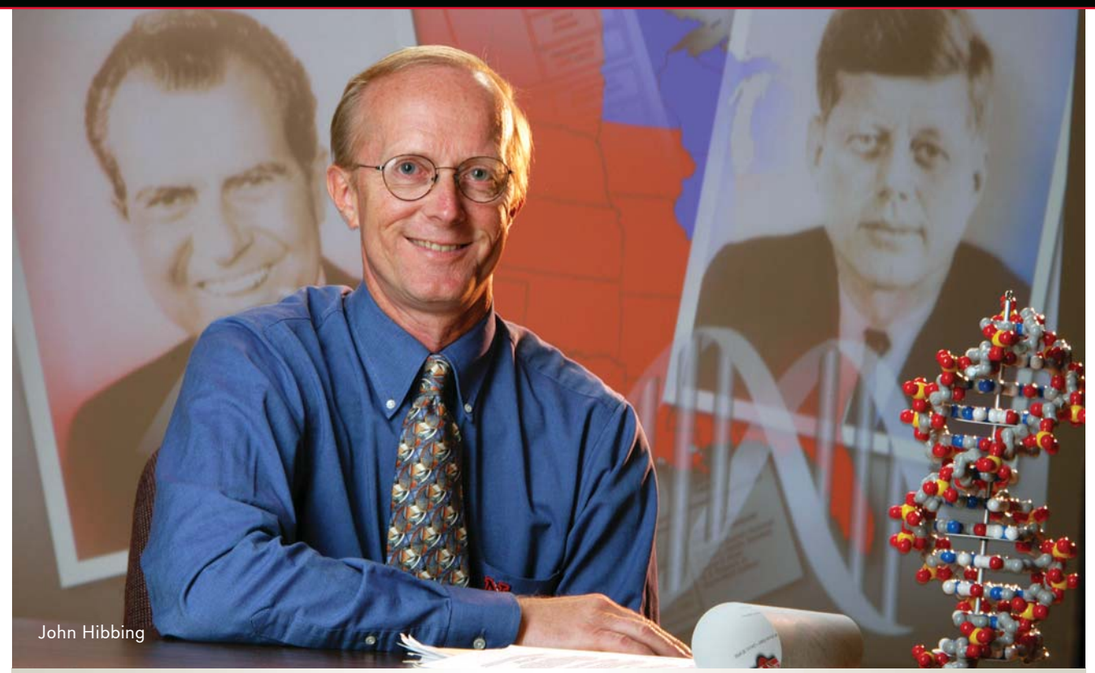
The tribal council approved the project and a tribal advisory board guides the program and is helping to develop the curriculum and other materials.

"This is the Omaha horse therapy-assisted prevention program," Whitbeck said. "When we leave, they will own this program." Findings also should help other Native nations interested in creating horse-assisted prevention programs.

Shonga Ska 'Firsts'

Shonga Ska has been punctuated with firsts. Researchers believe it's the first NIDA-funded prevention program for Native Americans involving horses. And Anitra Mallory, who received her bachelor's degree in psychology in December 2005, was the first graduate from UNL's Great Plains Cultural Ways program. This is the only National Institute of Mental Health-funded Career Opportunities in Research program that focuses solely on Native Americans undergraduates who aspire to work in mental health within their cultures.

Mallory is pursing her master's in counseling psychology, wants to earn a doctorate and plans to work with American Indian children and parents. She hopes to incorporate horses into her therapeutic work.


John Hibbing

GENES AND POLITICAL TEMPERAMENT

Political scientist John Hibbing assumed, like most of us, that our political views stem from our life experiences. So he was "shocked" by his own findings and so were others. It seems our conservative or progressive outlooks have as much to do with our genes as our upbringing.

Hibbing, a UNL Foundation Regents University Professor of Political Science, along with John Alford of Rice University and Carolyn Funk of Virginia Commonwealth University, studied attitudes of more than 8,000 sets of twins about 28 issues, such as capital punishment and taxes. By subtracting the rate at which fraternal twins, who share half of their genes, agreed on an issue from the rate that genetically identical twins agreed, researchers calculated how much genetics influenced attitudes on that issue. They assumed twins raised together experienced similar upbringings.

Overall, they found 53 percent of political beliefs come from genetic inheritance, though the percentage varied somewhat depending on the issue. Opinions on school prayer, property taxes and the draft, for example, were most strongly influenced by genes, while views on federal housing and divorce were less so.

Scientists have long known genes play a role in our personal and social temperaments, but Hibbing is one of the first to explore how genetics affects our beliefs of how society should be organized – our political temperament. He and his colleagues are expanding this research to explore specific genes that may influence political behavior.

However, Hibbing stresses that doesn't mean there's a specific gene that makes one liberal, conservative or even apolitical. Rather, genes create a propensity to view the world in certain ways and that viewpoint influences our political decisions. For example, characterizing a guest-worker program as "amnesty" for illegal immigrants may stem from an underlying belief that perceived rule-breakers should be punished.

So, are bloggers and talk show hosts discoursing for nothing? Perhaps, but not because we're genetically inconvincible.

"Nobody's talking genetic determinism," says Hibbing, adding that people's politics are a complicated mix of numerous genes interacting with the environment. No one should fear a day when genetic engineering could manipulate elections.

Instead, Hibbing hopes his research leads to greater understanding. Your cousin may not be willfully bullheaded; he's just genetically wired to view the world differently.

MOVING DISCOVERIES TO THE MARKETPLACE

Moving UNL researchers' innovative discoveries from the lab to the marketplace enhances the public's health and well-being and contributes to economic development.

Home-grown Cholesterol Fighter

A partnership between UNL and a regional beef company could lead to commercialization of a novel cholesterol-fighting compound made from Nebraska-grown ingredients.

Nutrition scientist Tim Carr discovered that combining stearic acid from beef tallow and sterols from soybeans creates a powerful cholesterol buster. While plant sterols' cholesterol-lowering ability is well-known, Carr's research revealed stearic acid, a "good" saturated fat, also fights cholesterol. The combination outperformed plant sterol food additives in animal studies and appeared to work as well as widely prescribed cholesterol-lowering statin drugs. Now it's being tested on people.

Tim Carr with cholesterol-fighting compound.

Under an agreement with the university, Beef Products Inc. (BPI) funded a human clinical trial of Carr's tallow/soybean combination in 2006. If it proves effective, BPI has the option to commercialize the compound for food applications. BPI, based at Dakota Dunes, S.D., is the world's leading manufacturer of boneless beef with plants in Nebraska and three other states and is a leading producer of high quality stearic acid.

The clinical trial is a critical step toward commercialization. Results will allow the university to license the compound to BPI for food uses, which could quickly make it available to consumers.

Consumers nationwide and Nebraska's economy could benefit. UNL is patenting Carr's compound and also exploring its potential as a dietary supplement. "I'm excited about the potential of this for consumers looking to manage their cholesterol," Carr said.

Better Bone Implants

Chemist Jody Redepenning is building better bones – or, to be more precise, better implants.

Redepenning discovered a simple electrochemical process for making bone implants. UNL patented his process, which could lead to a biocomposite material that could be used to make bone replacements, screws, other orthopedic appliances or medical devices. This biocomposite is as strong and flexible as bone and has applications in dentistry as well as orthopedics.

During the healing process, the body ultimately would absorb the material and redeposit it as living bone. "The idea is for it to go away," he said.

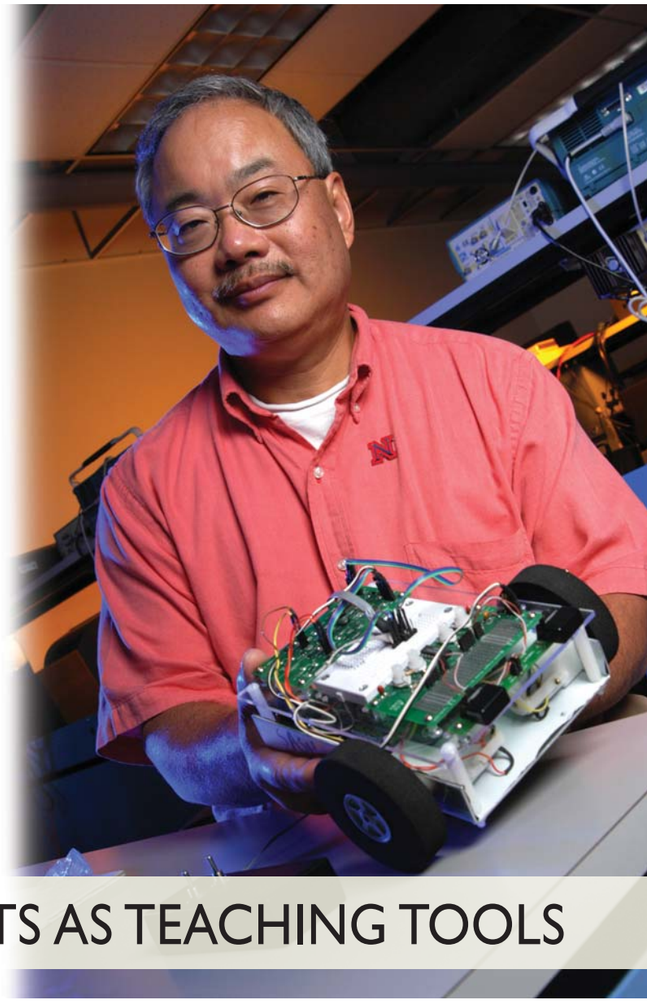
Redepenning is refining the process for producing the biocomposite. He thinks scientists eventually could come up with something stronger than bone.

TURNING LOOSE TEKBOTS AS TEACHING TOOLS

Call it "Invasion of the TekBots." At the Peter Kiewit Institute, these little robots – raw circuitry and wires on wheels – are rolling into classrooms, morphing into high-tech gadgets with wireless communication and video systems as innovative students tinker with them.

Bing Chen, chair of UNL's Computer and Electronics Engineering Department at the Omaha-based institute, couldn't be happier with these 21st-century teaching tools. He introduced TekBots to the university's engineering programs two years ago to encourage students to think creatively about applying classroom knowledge and to have fun with engineering. Now, he's letting TekBots loose in Omaha's middle schools with his new Silicon Prairie Initiative on Robotics in Information Technology, or SPIRIT, program.

Funded by a $1.2 million four-year grant from the National Science Foundation and in collaboration with Omaha Public Schools, SPIRIT is teaching middle school teachers to use TekBots to illustrate algebraic equations and to demonstrate such principles as friction, wireless and computer processing, and electronics. For example, students can learn the circumference of a circle equals $2\pi r$, then ink a TekBot wheel, measure it for themselves and use the equation to calculate revolutions and distance.



Bing Chen with a TekBot.

Students, Chen said, "don't always see the payoff to what they're studying." He thinks that's one reason fewer American students choose math and science careers. He designed SPIRIT to introduce young people to math and science at an early age and perhaps encourage more of them, particularly underrepresented women and minorities, to choose engineering careers.

"The teachers are, obviously, the front line," Chen said. So in summer 2006, about 40 middle school teachers built their own TekBots and, with the help of UNL engineers, brainstormed lesson plans for their classrooms. SPIRIT aims to train 100 teachers in the next three years. The program will host a Web site and ongoing training so teachers can share stories and new ideas. UNL engineering students will mentor middle school students throughout the school year.

Chen hopes the classroom is just the beginning for TekBots. He envisions robotics clubs and citywide TekBot competitions in which student-designed robots must complete mazes and other challenges.

"I see this as a mechanism for the 21st-century Soapbox Derby."

Opposite: Derrick Nero, a teacher at Omaha's Lewis and Clark Middle School, works on a TekBot.

UNDERGRADS EXPERIENCE RESEARCH FIRSTHAND

The National Science Foundation's Research Experience for Undergraduates (REU) program attracts students from smaller, less research-oriented colleges and historically minority institutions, to UNL. One goal is to encourage minority students to consider graduate school at UNL or elsewhere as part of a broader effort to enhance diversity in the professions and sciences.

Redox Biology

From molecular medicine to environmental and plant biochemistry, REU students at UNL's Redox Biology Center experience leading-edge science firsthand.

For 10 weeks each summer, students from small colleges join UNL faculty in their labs to work on independent research and participate in laboratory life. UNL and University of Nebraska Medical Center scientists in the center investigate aspects of redox biology, the study of oxidation/reduction processes necessary for cellular life, but which also lead to aging and diseases such as cancer and heart disease.

The center began hosting undergraduate students in 2004 as a pilot project funded by UNL's Office of Research. In 2006, it became an official REU program funded by NSF and the Department of Defense.

"The benefit is outreach," said Don Becker, an associate professor of biochemistry who leads this REU. "We help students who go to smaller institutions with limited resources get some research experience in the summer."

The program also encourages minority students to come to UNL. Working closely with leading scientists in the field exposes students to new career options. "Our goal is to increase diversity in the sciences," Becker said.

Michael Jacobsen from Laurel, Neb., a student at Wayne State College in northeast Nebraska, is proof of the program's benefits. After a successful summer of working with biochemist Vadim Gladyshev, he returned for two weeks during holiday break and co-authored a scientific paper.

Biochemists Steve Ragsdale (left) and Don Becker in the lab with REU students in UNL's Redox Biology Center.

Environmental Math

REU students who work with Glenn Ledder, associate professor of mathematics, test their math skills on an interdisciplinary real-world question and know they've contributed to expanding knowledge.

Working as a team, Ledder's three summer students learn about biology and math as they analyze environmental problems such as how species interact under differing conditions; under what circumstances a bass resorts to cannibalizing its larvae; or, as his first students did in 2004, predict how a disease in fish alters the relationship between the fish and predatory birds. Their results were published in a respected undergraduate journal.

"In today's world, things change quickly," Ledder said. "So an important part of a college education nowadays is learning to become self-educating. A research project is a great way to learn how to do that."

Psychology and the Law

How do juries make decisions? How reliable is eyewitness identification? REU students interested in questions where psychology and the law intersect can spend an entire year at UNL, taking courses and working with faculty on independent research projects.

Students receive training not offered at their own schools. Faculty also benefit, said UNL psychology professor Richard Wiener. The program encourages minority students from across the nation to study at UNL. "The diversity of students helps us think about our work from different perspectives," he said.

GOLDWATER RECIPIENTS

Research is an essential part of the college learning experience for UNL's two 2006-07 Goldwater Scholarship recipients.

Jeanine Frey, a biochemistry major from Hay Springs, and James McFarland, an electrical engineering major from Lincoln, are among 323 students nationwide to receive this scholarship based on academic merit. Chemistry major Jessica Peinado earned an honorable mention. Named for the late Arizona Sen. Barry Goldwater, the nationally competitive scholarship encourages careers in math, the natural sciences and engineering. It's the premier undergraduate award of its type in these fields.

Frey and McFarland participate in the University Honors Program and work closely with UNL researchers through UCARE, UNL's Undergraduate Creative Activities and Research Experiences program.

Goldwater scholarship winners Jeanine Frey and James McFarland.

Frey plans to earn a doctorate in biochemistry, conduct biomedical research focusing on gene expression as it relates to human disease and teach at a research institution. She works with biochemist Julie Stone.

McFarland aims to earn a doctorate in electrical engineering and conduct research focused on solid-state semiconductors at a major university. He works with electrical engineer Jerry Hudgins.

They are among the 350-400 UNL undergraduates who experience research firsthand annually through UCARE, said Laura Damuth, undergraduate research director and national fellowship adviser in the Office of Undergraduate Studies, which sponsors the program. UCARE pairs researchers and undergraduates, who work as research assistants the first year before launching independent projects the second year. About 80 percent of UCARE participants plan to attend graduate school and 98 percent of UNL's applicants for national scholarships have participated in the program.

"UCARE is integrating UNL's research and teaching missions," Damuth said. "Our premier scientists are sharing their expertise with our undergraduates."

FOSSILS GOING ONLINE FOR EASY ACCESS

The University of Nebraska State Museum's well-known fossil collection is getting an extreme makeover that will benefit scientists and educators worldwide.

The museum's extensive collection of fossils from mammals that lived in North America over the past 40 million years ranks among the nation's top 10 most significant. A two-year, $498,000 grant from the National Science Foundation is funding facility renovations, reorganization and creation of an online database.

Leading this work are Robert Hunt Jr. and Michael Voorhies, professors of geosciences and museum curators in UNL's nationally recognized vertebrate paleontology research program. They will develop the database featuring much of the collection and centralize the fossils, which now reside in several locations. This work will make information about the collection easily available on the Web for scientists and educators worldwide.

"This will give us access to specimens of very rare and unusual prehistoric animals that in some cases have been in plaster jackets for many years," Voorhies said. "It's almost like opening Christmas presents from 50, 60, 70 years ago that haven't been accessible to the scientific community."

The museum's fossils were last cataloged nearly 15 years ago. Strides in database and Web technology will make this new effort more user-friendly and comprehensive.

Collections manager George Corner and some of the fossils that will be available online.

TRAINING NATIVE AMERICAN TEACHERS

Nebraska's Native American students are seeing more familiar faces than ever thanks to a UNL project that's training Native teachers.

UNL's Native American Career Ladder has graduated 19 Native American students, including four in 2006, who are teaching mostly in reservation schools at Macy, Santee, Walthill and Winnebago. Most were the first in their family to receive a bachelor's degree, said Nancy Engen-Wedin, of the College of Education and Human Sciences and project director. "We now have more certified Native American teachers in Nebraska than we've had in our state's history."

The project began in 1999 with a $1.25 million six-year U.S. Department of Education grant. In 2006, UNL received a second four-year $750,000 education department grant to extend this effort with the Indigenous Roots Teacher Education Program. The new program, which has enrolled 15 students, continues a partnership between UNL, Little Priest Tribal College, the Nebraska Department of Education and five northeast Nebraska K-12 schools.

Nancy Engen-Wedin

Students must have associate degrees to enter the program. They graduate from UNL after taking distance and traditional classes at Little Priest, Nebraska Indian Community College and UNL. Coursework emphasizes Native language learning and culturally relevant approaches.

Research suggests Native students benefit academically from having Native American teachers. "It will make a significant difference if we continue to place Native role models as teachers in classrooms with Native American kids," Engen-Wedin said.

The College of Education and Human Sciences and UNL Extension are working on a similar project for English language learners. The Northeast Nebraska Para Educator Career Ladder project aims to place bilingual minority teachers in northeast Nebraska's diverse classrooms. The project is developing a cadre of ethnically and linguistically diverse elementary teachers.

Bill Lopez heads the five-year $1.97 million U.S. Department of Education grant that includes educators and students from UNL, Northeast Community College in Norfolk, Central Community College-Columbus and Wayne State College. The first 10 students received their associate degrees in 2005 and transferred to UNL's elementary education program. Students take courses from UNL and Wayne State. The first group will graduate in December 2007.

CELEBRATING EXCELLENCE, COLLABORATION

The Nebraska Lectures

A biochemist and a potter drew on personal experiences as faculty scholars to illustrate their presentations for the 2005-06 Nebraska Lectures: the Chancellor's Distinguished Lecture Series. Co-sponsored by the Research Council, the Office of the Chancellor and the Office of Research and Graduate Studies, these lectures feature prominent UNL faculty.

Ruma Banerjee, George Holmes University Professor of Biochemistry, discussed how simple nutrients like vitamins regulate genes and modulate health and disease in her lecture titled "Genes, Greens, and Disease." Her research focuses on homocysteine, a substance essential for health but toxic at elevated levels. Homocysteine has been implicated in heart disease risk, Alzheimer's disease and fetal neural tube defects. Banerjee heads UNL's Redox Biology Center, which was established in 2002 with a $10.5 million grant from the National Institutes of Health.

In her lecture, "What Is It About Pots?," Gail Kendall, a potter and professor of art, showed examples of her award-winning work and discussed her development as a ceramic artist. Kendall uses techniques from pottery made thousands of years ago. She is interested in functional uses of pottery and the bulk of her art is composed of pottery items used in daily life.

UNL Research Fair

The fourth annual UNL Research Fair in April 2006 celebrated faculty achievement and student research, and featured speakers who discussed interdisciplinary collaboration and federal funding opportunities.

Speakers included: Jessica Glicken Turnley, Galisteo Consulting Group Inc.; George Legrady, University of California, Santa Barbara; Brian Humes, Deborah Lockhart, Kevin Lyons and Mary Lynn Realff, all National Science Foundation; Bill Valdez, Department of Energy; Paul Eakin, University of Kentucky; Eric Howard, Fulbright Academy of Science and Technology; Scott Somers, National Institutes of Health; Donald Leo, Defense Advanced Research Projects Agency; and Dennis Sorensen, Office of Naval Research.

The Office of Research and Graduate Studies offered workshops on research ethics and responsibility, grants management and the graduate school experience. Graduate students competed in oral presentation and poster and display competitions; undergraduates presented their research results at the Undergraduate Research Fair. Highlights included the annual recognition breakfast honoring faculty whose research and creative activity was selected for major sponsored program funding.

Enhancing UNL's Interdisciplinary Culture

Interdisciplinary collaboration in research and scholarship is increasingly crucial in addressing the complex problems of the 21st century. A faculty retreat to stimulate discussion and strategies for enhancing UNL's interdisciplinary culture was held in May 2006 at the Lied Lodge and Conference Center in Nebraska City, Neb.

The retreat brought together UNL faculty from diverse disciplines to consider the interdisciplinary aspects of two broad topics: science and mathematics education and transportation. It was sponsored by the UNL Research Advisory Board and Office of Research in partnership with the Office of Academic Affairs, Institute of Agriculture and Natural Resources and the Office of the Chancellor.

Three speakers provided their perspectives on the opportunities and need for interdisciplinarity. In the keynote address Theodore Brown, co-chair of the National Academies Committee on Facilitating Interdisciplinary Research and founding director emeritus of the Beckman Institute for Advanced Science and Technology, discussed the committee's findings and the successes and challenges experienced at the Beckman Institute in creating an interdisciplinary environment.

Dan Murray, vice president of research for the American Transportation Research Institute, spoke about the need for a cross-cutting approach to the broad array of issues encompassed by transportation. These include safety, human and environmental factors, economic analyses, technology and training, and transportation security.

Jeffrey Osborn, outreach professor for the Appalachian Math and Science Partnership at the University of Kentucky, addressed math and science education issues. Osborn discussed his experiences with both inner city and rural education with a focus on enabling teachers and students to experience "science in action."

The retreat included presentations by UNL centers and programs involved in the focus areas and breakout groups aimed at selected topics.

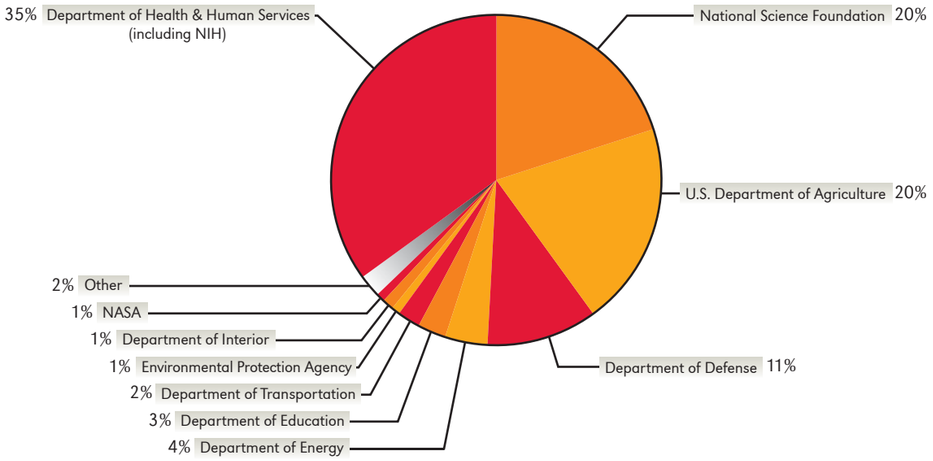
Four Corners Research Alliance

The Four Corners Research Alliance was formed in 2005 to build on the expertise of the major research universities in Nebraska, Kansas, Iowa and Missouri. Senior research officers from the University of Nebraska-Lincoln, University of Kansas, Kansas State University, University of Kansas Medical Center, University of Iowa, Iowa State University and the University of Missouri are leading efforts to identify priority areas for research collaborations.

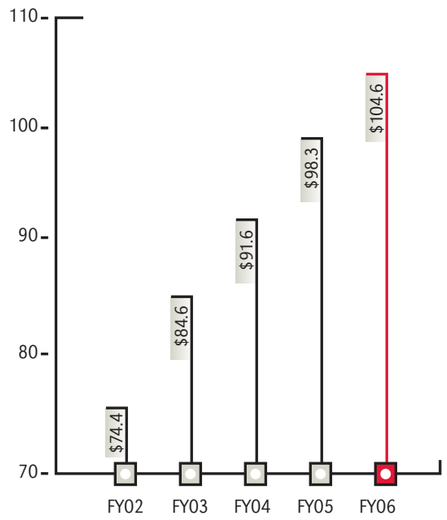
"Our region offers great expertise that, developed collectively, will enable us to compete for major national centers and other large-scale opportunities," said Prem Paul, UNL vice chancellor for research. "We are excited about the potential collaborations in research programs and infrastructure development that the Alliance is identifying."

FINANCIALS

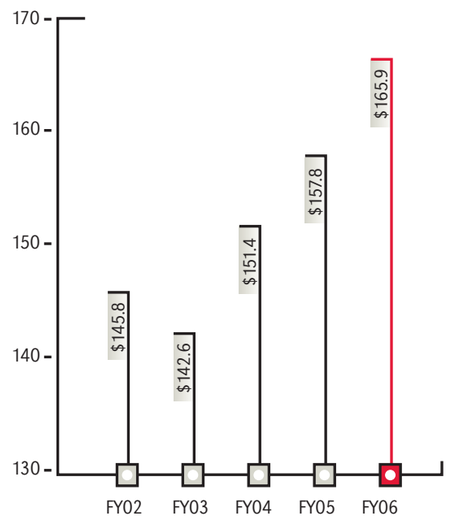
Research Funding by Federal Agency



Five-Year Total Research Funding
(in millions)



Five-Year Total Sponsored Programs Funding
(in millions)



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