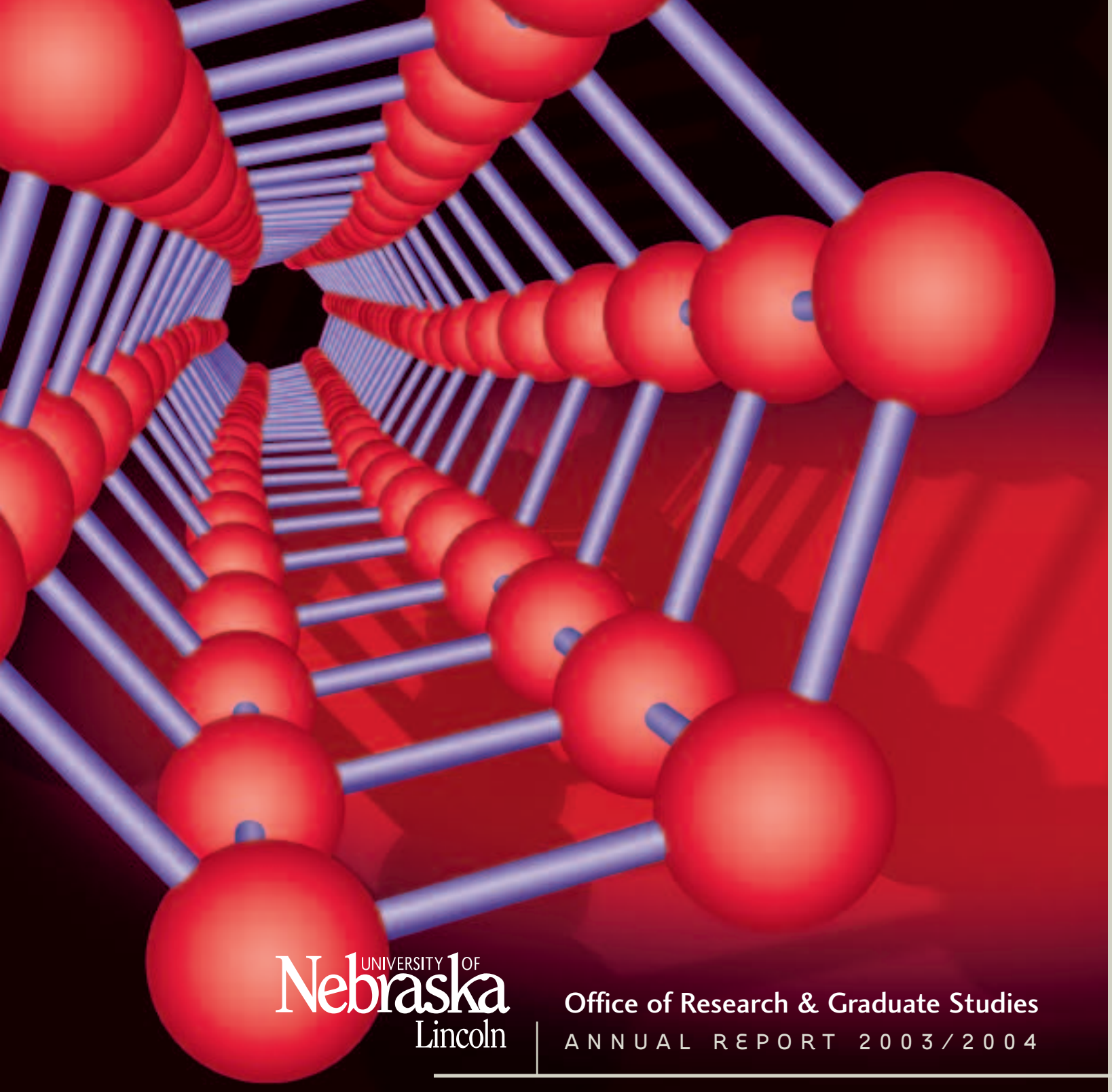

University of Nebraska Lincoln

# Office of Research & Graduate Studies

## ANNUAL REPORT 2003/2004

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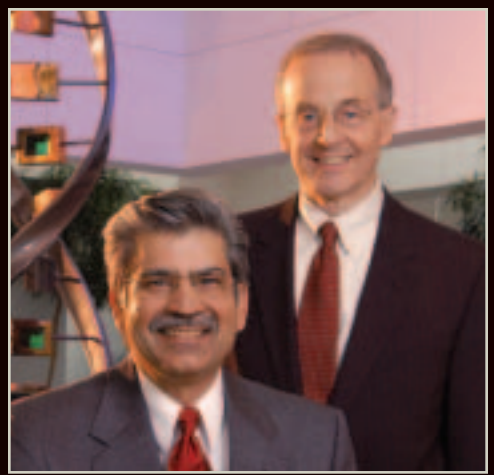
**On the cover:** A computer model of a thin silicon nanotube, created by UNL Chemist Xiao Cheng Zeng.

# Welcome to Research & Graduate Studies at Nebraska

Research is on the move at the University of Nebraska-Lincoln. In the year ending in June 2004 we attained record levels of external funding and gained recognition for scholarly achievements.

Our major 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 thrive, making major advancements in their fields – some highlighted in this report – and attracting talented faculty to campus.



Prem Paul, vice chancellor & Harvey Perlman, chancellor

Interdisciplinary teams of UNL scientists have initiated collaborations with the public and private sectors to create a network of partnerships that are yielding important research. Our sociologists are working with researchers from four other institutions to look at the family consequences of infertility and an international team led by a UNL chemist has modeled nanotubes with amazing new properties.

UNL researchers are making important contributions to homeland security and defense. Our software engineers are developing methods to create and test software for dependability, particularly in security-critical applications. We are working with the U.S. Capitol Police to develop threat assessment protocols to protect Congress. And we are developing a key technology to enable production of a revolutionary bandage that will save lives on the battlefield and in the emergency room.

UNL scholars are enriching public life with significant works. We have published the first *Encyclopedia of the Great Plains* and commissioned a piano piece from a great American composer to commemorate the Lewis and Clark Expedition.

The close integration of our research priorities with our established programs of excellence is driving this success. Strategic investment of university funds, Nebraska Research Initiative and Nebraska Tobacco Settlement funds enable us to support innovative research projects and to hire top faculty and provide them with the equipment and facilities to achieve their goals. As we enhance our research programs we also are strengthening our commitment to technology development and economic development through commercializing innovative products and processes.

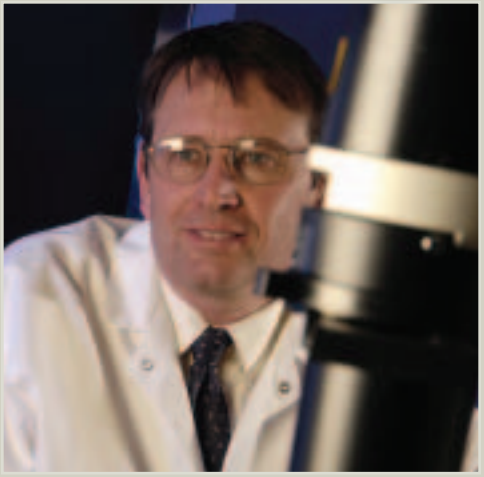
This annual report tells only a few of our success stories during the past year. We invite you to visit www.unl.edu/research for more information.

UNL is on the move and we believe that through our continuing pursuit of excellence and investment in our faculty, we can sustain this momentum and achieve new levels of success in research and graduate studies.

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

# Recombinant Bandage Could Be Battlefield Lifesaver

More than 50 percent of all combat casualties result from soldiers bleeding to death on the battlefield. UNL biomedical engineer William Velander believes many of these lives can be saved with bandages from recombinant fibrinogen – a genetically modified blood protein – produced using a method he invented.



William Velander

"With combat wounds and other kinds of catastrophic injuries, the body can't mobilize enough natural plasma fibrinogen and other clotting system components to the wound site to stop bleeding," Velander said. Bandages made with fibrinogen have been shown to rapidly stop bleeding and promote clotting, keeping the wounded alive until he or she can get necessary medical attention.

Fibrinogen bandages work, but fibrinogen derived from human plasma is so scarce and expensive that it has prevented commercial development of a bandage. Velander has solved this problem by inventing a process for producing an inexpensive and abundant supply of fibrinogen from transgenic pigs – pigs bred with a human gene that enables them to produce fibrinogen in their milk. An added benefit: Fibrinogen produced from disease-free pigs is safe from contamination with HIV, hepatitis C virus and other blood-borne contaminants that may be present in human plasma.

Cheap, abundant, safe fibrinogen opens the possibility of an affordable bandage for battlefield use. Rather than the current cost of $1,000 per bandage, Velander estimates bandages made with his fibrinogen could cost as little as $10 each.

The fibrinogen technology also can play an important role in the medical needs of the general population when used to develop stents, catheters and other implantable devices with increased biological compatibility, Velander said.

Velander, in collaboration with UNL's Biological Process Development Facility and the University of Nebraska Medical Center and with $3.5 million in funding from the Department of Defense, is further developing processes to produce recombinant fibrinogen and other proteins for bandages and implant devices and conducting research and clinical studies on their effectiveness. He also plans to investigate fibrinogen-based biocompatibility in vascular stent and catheter surfaces and evaluate the technology in preclinical small- and large-animal studies.

One fibrinogen-based bandage (lower left) can replace up to 14 yards of traditional gauze bandage.

Steve Goddard

# Applying Advanced Computing to Everyday Problems

In applications ranging from robotic highway markers to helping farmers manage the impact of drought, computer scientist Steve Goddard is applying basic computer science research to real-world problems.

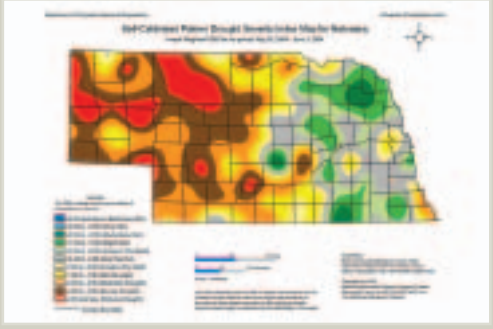
Goddard readily admits a fascination with the mathematics of scheduling theory – it's his idea of fun – but applying the esoteric side of computer science to the everyday is the real challenge. An example is his work in energy-aware computing, aimed at saving as much energy as possible while still providing the bandwidth needed for processing or communications. This has important applications in embedded sensor systems, which are critical elements in many technologies, he said.

"Embedded sensor systems run on batteries, and the system is only functional as long as the batteries are good," Goddard said. "Our work focuses on maximizing the life of the battery while still meeting all of the system needs."

Goddard is applying this approach in robotics technologies, such as robotic highway markers that can be programmed to position themselves on the highway. A new application is in assistive technologies – using wireless networks to create home environments that allow people with disabilities to live independently.

A second area of Goddard's research is in developing new architectures for decision-support systems. "We are studying new ways of building these systems that make it easier to add new functions and abilities and distribute them across multiple systems," he said.

The National Agricultural Decision Support System, developed by Goddard and colleagues with funding from the National Science Foundation and the U.S. Department of Agriculture, applies this technology. The system supplies drought index and exposure-analysis tools in a user-friendly interface that can help farmers assess the risk of drought and its potential economic damage.



This map, showing drought levels in Nebraska, was created using information derived from advanced computing technologies developed by Steve Goddard for UNL's National Drought Mitigation Center.

"We're now applying the technology to other domains, such as hydrological observations," Goddard said. "This is very collaborative, interdisciplinary research, where we have developed a general computing framework that can be applied in many areas of research."

# Software Engineers Focus on Dependability Analysis and Testing

UNL moved to the forefront of the software engineering field with the hire of two new faculty members with expertise in software dependability.

Gregg Rothermel & Matt Dwyer

Gregg Rothermel, Jensen Chair of Software Engineering, and Matt Dwyer, Henson Professor of Engineering, joined UNL with considerable experience in industry and academic research programs. Both work on the same problem – ensuring that software is sufficiently dependable – but they approach it from different angles. These diverse approaches make their work exciting, they said.

"We had areas of natural connection," Dwyer said, "but we also bring successful funding records with industry and government. And we'll be able to use our combined expertise to make bigger and better things happen."

Dwyer's research involves using static analysis techniques to predict the behavior of a software program before it's deployed. This is critical for industries like aviation or medicine, where a software malfunction could be deadly. Rothermel has focused on dynamic analysis and testing of products as they evolve – making sure revisions work with other products as promised.

The two approaches have similarities that when merged can produce substantially more effective software and analysis tools. "Our real goal is to have our software engineering group become one of the top five in the world. It won't happen overnight, but it's a very realistic goal," Dwyer said.

# Guggenheim Fellow Models Thinnest Known Silicon Nanotube

Xiao Cheng Zeng

Models of silicon nanotubes created by Xiao Cheng Zeng and his research team appear to behave like a metal, losing the semiconducting properties that have made three-dimensional silicon one of the foundation materials for the modern electronics industry. "To find that these tubes are very likely to be metals instead of semiconductors is very surprising," said Zeng, a UNL chemist. "Scientists have studied silicon for more than 50 years and it's the cornerstone material for the modern semiconductor industry."

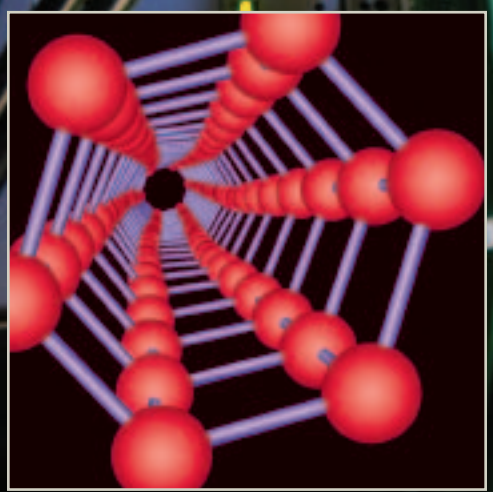
Using UNL's PrairieFire supercomputer, the team created models of silicon tubes less than 1 nanometer in diameter in hexagonal, pentagonal and square configurations. In the process, they found the thinnest known nanotube – a square configuration less than 0.5 nanometer in diameter – that appears to be a conductor when analyzed with quantum mechanical methods. The result was published in the Feb. 23 issue of the *Proceedings of the National Academy of Sciences.*

This work and Zeng's previous research on computational and theoretical studies of liquids, solids, thin films, interfaces, nanotubes and nano-clusters led to his selection for a John Simon Guggenheim Memorial Foundation Fellowship for 2004.

The *Proceedings* paper follows two papers on low-dimensional water and ice published in *Nature* in 2000 and 2001 by Zeng and his friend, Hideki Tanaka of Okayama University in Japan. It was while discussing the earlier papers with his father, J.Y. Zeng, a retired professor of quantum physics at Beijing University in China, that Zeng became interested in the quantum systems that led to the most recent discovery. "Three years ago, when I visited my dad, I talked about these water studies," Zeng said. "He had studied low-dimensional quantum effects and suggested that I look in that direction. In our work with water and ice, we used the classical physical model without considering quantum effects."

Considering quantum effects proved to be crucial in the work on silicon nanotubes and required someone with a solid background in solid-state and quantum physics. Zeng, a computational and theoretical physical chemist, teamed up with Jail Bai, a UNL doctoral candidate in physics and the lead author of the *Proceedings* paper.

Bai joined Zeng's lab in 2001 and for nearly three years, they attacked the problem of understanding the sub-atomic behavior of the tiny silicon tubes, finally succeeding last year.



A computer-drawn snapshot of the structure of a hexagonal, single-walled silicon nanotube as modeled by Xiao Cheng Zeng.

Fred Choobineh

# Nutritional Genomics, Nanomaterials Win EPSCoR Funding

Four research projects at four Nebraska universities will share $9 million in National Science Foundation funding secured through the Nebraska EPSCoR program. The funded projects include research in nutritional genomics, cell biology, nanomaterials and mobile computing.

Some $4.7 million of the grant creates the Metabolite Signaling Center at UNL to study how the complex chemicals in food (metabolites) influence organisms' growth and development. New genomic technologies have increased the feasibility of deciphering such complex interactions. Biochemist Mike Fromm leads a team of scientists from UNL and the University of Nebraska Medical Center. This is a new area of research with possibilities for development of agricultural products with compositional changes that would benefit humans and livestock.

The grant also creates a $1.6 million Nebraska Center for Cell Biology at Creighton University to study the dynamic behavior of cells using sophisticated optical imaging technologies. The project, a collaboration with researchers at the UNL College of Engineering & Technology in Omaha, will enhance research capabilities by developing expertise in the applications of physics to cell biology and neuroscience and includes an outreach component to make the center's instruments available to remote users utilizing Internet 2.

A $500,000 planning grant, led by UNL electrical engineer Ned Ianno, will be used to position Nebraska to submit large-scale proposals in nanomaterials science. A $500,000 planning grant team headed by University of Nebraska at Omaha's Hesham Ali and including researchers from UNO and UNL will work to establish a center to develop more-secure wireless computer networks. The overall grant also includes funding for student internships and research and development partnerships with Nebraska industry.

Nebraska EPSCoR is administered by the University of Nebraska Central Administration and directed by Fred Choobineh, professor of industrial and management systems engineering at UNL.

# Exploring the Genetics of Virulence in *Francisella tularensis*

In genetics it is the differences in organisms that count, and UNL molecular geneticist Andy Benson is finding important differences in an organism where no one could see them before.

Benson and colleague Paul Fey from the University of Nebraska Medical Center are studying genes in the bacterium *Francisella tularensis*, which causes the disease tularemia, to find out why some populations are more virulent, or highly infectious, than others. Little is known about the genetics of virulence in *Francisella,* which has become a critical issue since the bacterium's designation as a Category A bioterrorism agent.

Andy Benson

"We are trying to identify genes in *Francisella* that distinguish virulent from less virulent populations," Benson said. "The idea is that these genes could potentially encode proteins that are associated with virulence, and down the road these proteins could be targets for making vaccines."

In early genetic studies of *Francisella*, scientists had difficulties detecting any differences in the populations. But Benson's team is having better luck. In the past year they have mapped genes from different *Francisella* strains, and they are beginning to see variation. A recent grant from the National Institute of Allergy and Infectious Diseases is funding an extension of this work.

A collaborative team developed by UNMC pathologist Steven Hinrichs with the Armed Forces Institute of Pathology gave the team access to more strains of the bacterium. More strains, mean more differences – and the possibility of finding genes that might control virulence.

"It's hard to do genomics in these populations, but now we're seeing how these genes move around," Benson said. Their theory: Transposons, or "jumping genes," are involved.

"We think that the difference between virulent and non-virulent strains is a significant genetic change. It's essentially the difference between gain or loss of big chunks of DNA versus small base pair changes."

Benson and Fey's work grew from a *Francisella* project funded through the UNL/UNMC Research Collaboration Grants.

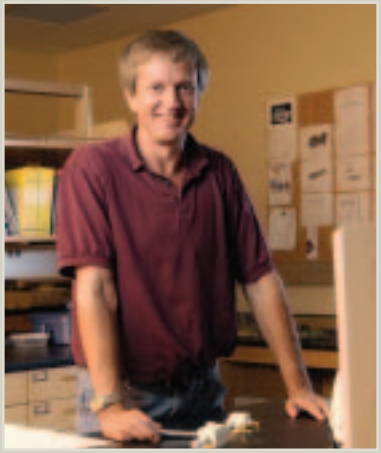
# Rapid PCR Device Enables Field Testing

Imagine being able to immediately diagnose a viral strain such as West Nile or SARS at the site of an outbreak or to identify anthrax on the battlefield. A device designed by UNL engineers for rapidly replicating DNA has the potential for these and other homeland security and biomedical applications.

Chemical engineer Hendrik Viljoen and mechanical engineer George Gogos received a five-year $1.4 million National Institutes of Health grant to further develop their rapid Polymerase Chain Reaction thermocycling technology. PCR is a technique for amplifying DNA samples to enable gene sequencing and identification.

DNA amplification that requires three to four hours with current technology takes only five to 10 minutes with Viljoen and Gogos' device. The device is also rugged, easy to transport and highly reliable, making it ideal for field tests such as HIV screening in Africa or detecting genetically modified DNA in foods.

"The rapid PCR uniquely positions us to pursue two other technologies," Viljoen said. "We can measure the PCR kinetics and the results are included in intelligent software, which will be part of the next generation of PCR thermocyclers. We have also started a program in assembly PCR. Short pieces of DNA are assembled, under conditions to minimize mutations, into larger structures."



Hendrik Viljoen

Viljoen and Gogos developed a novel device to enable the rapid heating and cooling of gases necessary for thermocycling of the DNA.

"This device makes our technology amenable to field usage," Viljoen said. "And it can handle volumes from 5 microliters to 40 microliters with outstanding sensitivity, while producing a high yield."

The NIH-funded project will add optical detection capabilities to the device, establish protocols for reverse transcription and the quantification of PCR and collect kinetic data of various polymerase enzymes to create mathematical models.

The UNL researchers have partnered with Michael Nelson, president of Megabase Research Products of Lincoln, Neb., who provides biochemistry expertise.

Hendrick Viljoen and George Gogos' prototype device enables rapid polymerase chain reaction thermocycling to amplify DNA samples for gene sequencing and identification.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# Understanding Selenium's Role in Cancer Prevention, Aging

Vadim Gladyshev

Selenium may be a micronutrient, but it is proving to have a macro role in biology.

"Research on selenium contributes to many important areas: cancer prevention, cell signaling, aging and redox biology," said UNL biochemist Vadim Gladyshev.

When Gladyshev began his research on selenium and selenium-containing proteins seven years ago, his primary focus was their role in cancer prevention. Today his work also includes collaborations with the UNL Redox Biology Center and the Nebraska Center for Cell Signaling and studies on the role of selenoproteins in aging.

Gladyshev continues his work on selenium and cancer, which is the subject of the largest-ever cancer prevention trial, the $180 million SELECT (***sel***enium and vitamin ***E c***ancer ***t***rial) study being conducted with the support of the National Institutes of Health.

"Selenium is a very potent cancer prevention agent, and SELECT will determine how well it works in prevention," he said. "What we are trying to understand is the basic mechanisms of *how* selenium prevents cancer."

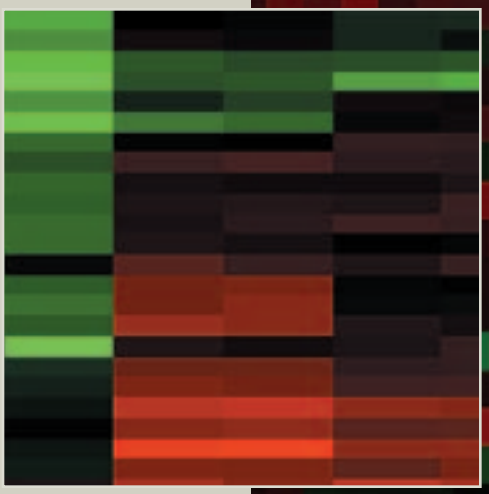
Gladyshev's work with selenium led him into the area of bioinformatics, using advanced computing techniques to search for selenoproteins in human, mouse and rat genomes. His team identified the full set of 25 human selenoproteins, including seven new ones – a result published in *Science* in 2003. Since then, the team has identified those proteins in many animals and nearly all microorganisms whose genomes have been sequenced.

"The philosophy in our lab is to develop computational predictions relevant to important biological questions and then to test them experimentally," Gladyshev said.

This is also the approach the lab is using to identify redox proteins and examine their targets and functions in the cell. A challenging new area of study for Gladyshev is the redox

biology of aging. A protein similar in function to one of his human selenoproteins has been shown to regulate lifespan in *Drosophila*. Gladyshev's lab is working with yeast – often used as a model system for studying aging – to understand if and how the selenoprotein might regulate lifespan. They found that in yeast, the protein extended the lifespan, and a combination of the protein and a calorie-restricted diet was particularly effective. The results were published in the May 25 *Proceedings of the National Academy of Sciences*.

Gladyshev's research is funded through the National Institute on Aging, the National Institute of General Medical Sciences and the National Cancer Institute.



A colorful look at genes whose expression is affected by aging in yeast, as published in the *Proceedings of the National Academy of Sciences*. Clusters of genes whose expression has been elevated are shown in red and those that decreased are shown in green.

# $M^2$ Institutes Mentor Middle School Teachers for Math Prowess

UNL's newly funded Math in the Middle Institute Partnership has an ambitious goal: to create the next set of leaders in middle school mathematics education who will mentor peers and offer challenging courses to their students.

Modeled on a successful program to teach aspiring elementary teachers how to teach mathematics, the four principal investigators have created an institute under which 120 teachers can earn master's degrees and gain confidence to teach at very high levels.

Mathematician Jim Lewis, educators Ruth Heaton and Thomas McGowan, and Lincoln Public Schools curriculum director Barbara Jacobson are co-directing the $5 million project funded by the National Science Foundation.

Middle school teachers typically have strong pedagogical skills but lack the deep knowledge to teach a challenging mathematics curriculum, Lewis said. Math in the Middle, dubbed $M^2$, aims to help those teachers learn math concepts that can be connected to the classroom and enrich their training to teach challenging courses creatively. The project seeks to validate the theory that teachers' deep understanding of content improves student learning, according to Heaton and McGowan. They also hope to learn more about how teachers become leaders and change agents in their schools.

Over the five years of the grant, four groups of about 30 teachers each will participate in three in-residence summer sessions and four non-resident academic semesters, and take 10 courses created by a team of mathematicians and pedagogy specialists.

Teachers accepted into the competitive program are expected to be among a district's best teachers, Lewis said. Their tuition is free and they will be paid to attend. The expectation is that they will become leaders in their home districts, teaching their peers as well as their students. The first cohort of teachers will come from Lincoln Public Schools; in successive years, teachers from greater Nebraska and neighboring states will be accepted in the program.

Lewis said the focus on middle-level teachers is deliberate. "We need to pay attention to what's happening in middle schools in order to be successful," he said. "We can't wait until high school to teach academic subjects seriously. By then, it's too late."

Jacobson said middle school is the gateway to high school success and efforts to improve student learning in middle school pay dividends throughout students' academic careers.

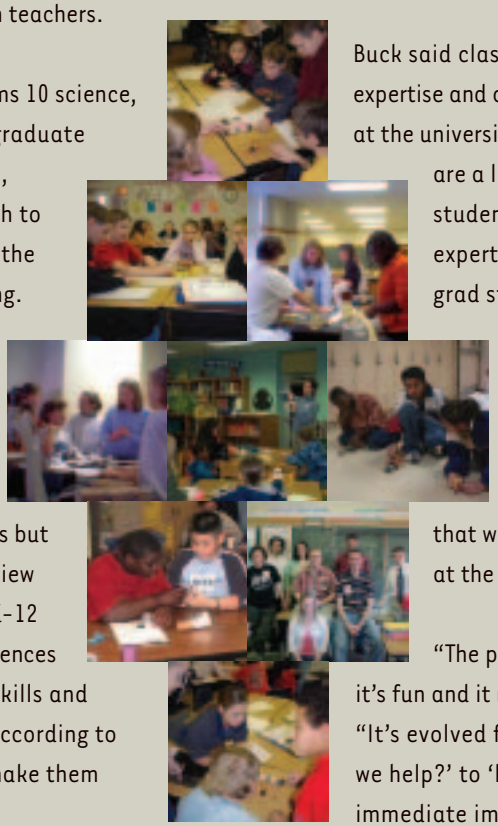
Clockwise from left: Thomas McGowan, Jim Lewis, Ruth Heaton and Barbara Jacobson.

Diandra Leslie-Pelecky & Gayle Buck

# Fulcrum Leverages Span Between Scientists and Middle Schoolers

Kids' enthusiasm for science is strong in elementary school but begins a steep decline in middle school. As the material gets more abstract, students ask more complex questions, challenging resource-lean teachers.

Each year, UNL's Project Fulcrum teams 10 science, technology, engineering and math graduate students with middle-level teachers, adding expertise and a new approach to the classroom. And the results from the project's first three years are exciting.



Coordinated by physicist Diandra Leslie-Pelecky and science teacher educator Gayle Buck, Project Fulcrum is not designed to convert graduate students into K-12 teachers but instead, to provide them a broader view of how scientists can contribute to K-12 education. Graduate students' experiences with Project Fulcrum broaden their skills and expand their leadership potential, according to Leslie-Pelecky. She believes it will make them better scientists in the future.

"They are gaining an empathy for teaching, especially for reaching the kids who don't easily 'get it,'" Buck said. "Grad students tend to have been the kids who easily understood science. Now they're having to learn new ways to approach a problem and new ways to explain concepts. They see the world differently now."

Buck said classroom teachers are able to leverage the expertise and creativity of the grad students. "Scientists at the university are ahead of what's happening – they are a living textbook," Buck said. Middle-level students are able to instantly tap into that expertise through experiments designed by grad students and gain access to equipment and knowledge at UNL.

The project received a second, $1.9 million three-year grant from the National Science Foundation in 2004 with the expectation that within five years, it will be institutionalized at the university and continue to prosper.

"The project shows the value of outreach – that it's fun and it makes a difference," Leslie-Pelecky said. "It's evolved from mere entertainment to 'how can we help?' to 'how is this helping?' We are seeing immediate impact."

# Empowering Parents to Prepare Kids for School Success

Parents are the first and best teachers of very young children. Yet many parents lack the skills that could help them prepare their children for success in school, and others are intimidated or lack experience with school settings. A new $5 million project, funded by the National Institute of Child Health and Development, will develop a comprehensive approach that merges parents' skills and schools' expertise to prepare children to succeed. The goal is to create stronger relationships among parents, children and schools in hopes that children will have more positive academic and social experiences.

Carolyn Pope Edwards & Susan Sheridan

"The goal is to strengthen and empower parents to become more actively engaged in their children's learning and development," said educational psychologist Susan Sheridan, lead investigator on the grant with psychologist Carolyn Pope Edwards.

The University of Nebraska Medical Center and Lincoln Public Schools are project partners in the study titled "Parent Engagement and Child Learning Birth to Five." The project will look to promote parents' strengths in three areas: warmth and sensitivity; encouragement of their young child's emerging curiosity and autonomy; and active participation in their child's learning and literacy, both in the home and in formal child care and educational settings.

Over the course of the five-year project, about 600 children and their families will be recruited, Sheridan said. The children will be monitored over time to measure the effects of implementing the parent intervention early, as compared to at a later age.

This work is important, she said, because educators recognize that "getting ready for school" is not just about the child; it is about parent and child readiness and building bridges between parents and educators.

Many prior research projects have studied the roles of parents and teachers, but no project has looked at how creating and supporting partnerships between families and schools can benefit young children across the entire birth-to-five age span, for both social-emotional and cognitive outcomes. "Our hope is that if we support parents and children early on, it will change the parents' perceptions of themselves and their roles in their children's education. It's important for parents to believe they are critical to their children's education and success, because they are," Sheridan said.

# When Does Behavior Escalate to Threat?

When U.S. postal facilities and Senate office buildings were contaminated with anthrax by a terrorist act in 2001, the U.S. Capitol Police called on the expertise of UNL psychologist Mario Scalora. And when the ricin attack occurred in 2003, Scalora was called to the Capitol again. Scalora's experience in behavioral threat assessment was instrumental in developing the threat assessment protocol now used to protect members of Congress in case of an attack. The Federal Protective Service of the Department of Homeland Security also has adapted the protocol. "We have developed a decision-making tool to assist law enforcement in assessing the risks posed by various sources," Scalora said. Threat assessment is examining and determining the level of threat an individual or organization poses at a certain time to specific targets, Scalora said.

"Most people think that terrorist acts occur out of the blue, but we find that terrorists often provide clues and warning signs of their intentions," he said.

Scalora believes that the behavioral assessment used in his research is a more reasoned and scientific approach to sorting out threats from a range of sources than the profile-based approach. "We're not profiling for individual characteristics; we are looking at patterns of behavior," he said. "Over time, the sources of the threat may change, but the behaviors don't."

Mario Scalora

UNL is one of the few academic institutions in the nation conducting behavioral threat assessment research and training, Scalora said. He has developed close research collaborations with federal, state and local law enforcement agencies, such as the U.S. Capitol Police and the Nebraska State Patrol, and with private and governmental threat assessment professionals and private industry.

Risk communications is a related area of Scalora's research. In the event of a terrorist attack, the content and timing of the information communicated to the public – and to the first responders and others on the scene – is critical. Public officials need to address immediately apprehensions and misperceptions about the risk to the public, Scalora said.

"Risk communication also is important when we are dealing with hoaxes and threats," he said. "Publicity about unsubstantiated threats can be as effective as an actual attack in eroding public confidence."

# Seeking Help: The Family Dynamics of Infertility

One third of American women will experience fertility problems during their reproductive years. Although medical science has made advances in fertility research, social and psychological questions have remained unanswered. For instance, why do only about half of infertile couples seek treatment?

Lynn White & Julia McQuillan

UNL sociologists Lynn White and Julia McQuillan and researchers from four other institutions won a $2.5 million grant from the National Institute of Child Health and Human Development for a five-year study of these key issues.

Little data exists on infertile couples who do not seek treatment or on the mental, social and behavioral outcomes of fertility treatments. The researchers will survey 7,500 women and 2,300 of their partners. The inclusion of males is unique, McQuillan said.

The study will explore what is known as "help-seeking theory" to learn what motivates or prompts people to seek medical help. For many medical issues, White said, how early one visits a doctor for treatment has an impact on the outcome. Scientists are interested in learning why people delay treatment and what might promote earlier help-seeking.

# The Great Plains from A to Z: An Encyclopedic Work

Nearly 15 years after its conception, the *Encyclopedia of the Great Plains* hits bookstores in fall 2004. Edited by UNL geographer David J. Wishart, the encyclopedia is published by the University of Nebraska Press.

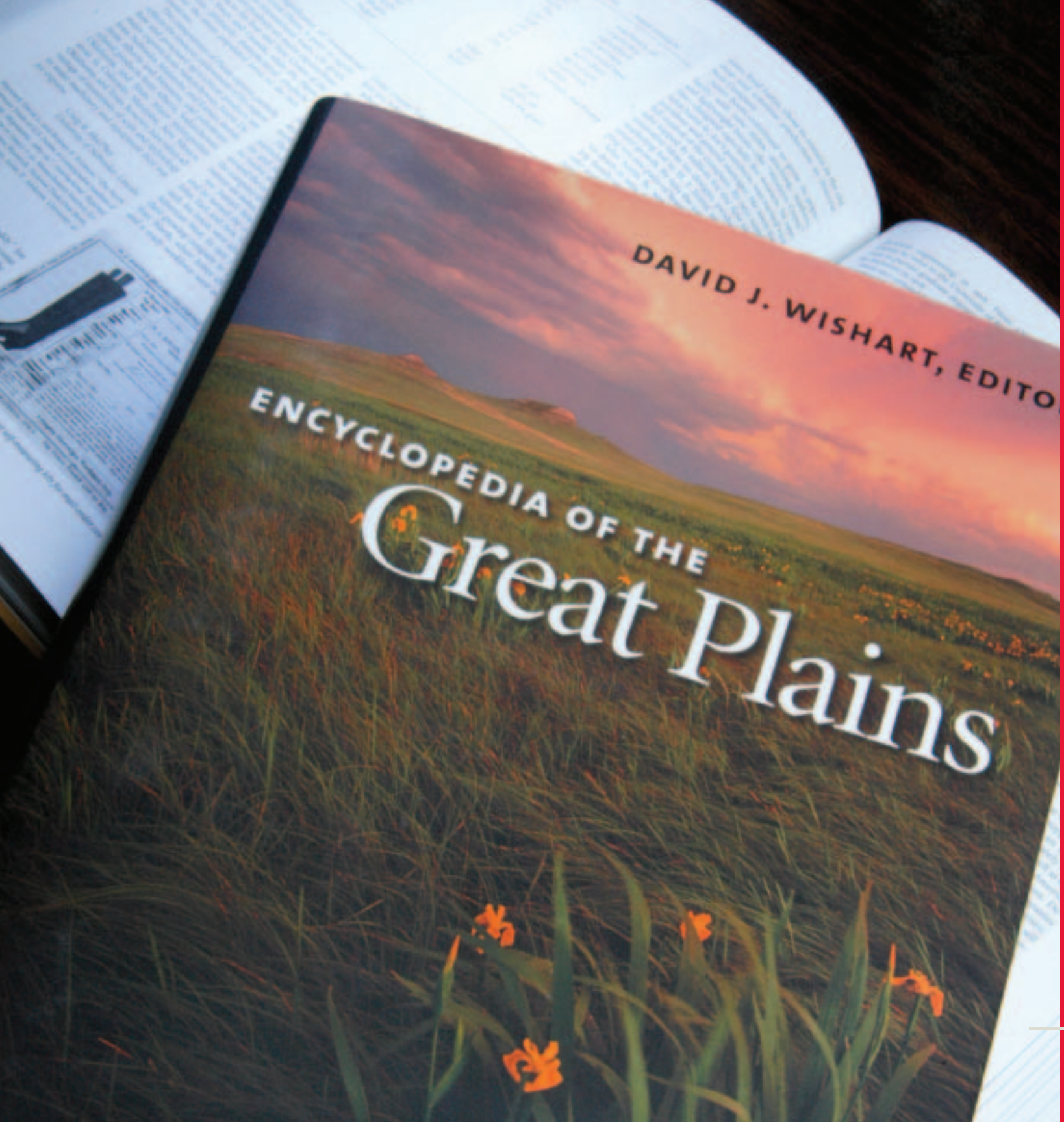
The Plains covers a huge geographic region – from Texas to Canada – and the encyclopedia is equally expansive. In 1,316 entries contributed by more than 1,000 scholars, the encyclopedia examines topics such as the geography, wildlife, botany, history, people, industry, weather, arts, literature and politics of the region. Particular attention has been paid to indigenous peoples who inhabited the region before Euro-Americans arrived in the 19th century, as well as more recent immigrants.

David J. Wishart

The single-volume book is organized into 27 topical chapters, each introduced by an essay, and includes an index and 250 maps and photographs. The contributing writers all volunteered their writing and scholarship, Wishart said. "They were remarkably gracious. Our instructions to the writers were to be accurate and interesting," he said. "That makes for a more accessible book." Wishart is an experienced writer; he is the author of two previous books published by the NU Press. The encyclopedia, however, presented different problems of organization and time management. "I do know how to do one of these now," he said.

Wishart and his team assigned each entry, then read and edited each as it came in. In the summer of 2003 they combed the final manuscript for accuracy. They finished reading some 870 triple-column pages of galley proofs in November 2003.

*The Encyclopedia of the Great Plains* is a cooperative project of the UNL Center for Great Plains Studies and the University of Nebraska Press, with the support of the National Endowment for the Humanities, the University of Nebraska Foundation and the Nebraska Humanities Council.


DAVID J. WISHART, EDITO
ENCYCLOPEDIA OF THE
Great Plains

Thomas Borstelmann

# Placing the United States in Global Context

Historian Thomas "Tim" Borstelmann has spent a career examining the United States in a global context. He conducts research on globalization and the process of international economic integration, including the United States' place in an increasingly unified world, and protests by opponents of that process.

"As a historian I am committed to structure and the more dramatic and obvious cultural manifestations of cultural change," Borstelmann said, including an examination of the underlying structures of economic power, who they benefit, and who has control and influence.

Borstelmann's recent books include *The Cold War and the Color Line: American Race Relations in the Global Arena*, in which he examines how the U.S. government responded during the post-1945 era to the rising demands for racial equality at home, in the civil rights movement, and abroad, in the decolonization movement. He argues that for U.S. policy-makers these were two sides of the same coin, and that waging the Cold War on behalf of the free world required moving away from racial discrimination and inequality. Borstelmann also co-wrote *Created Equal: A Social and Political History of the United States*, a U.S. history textbook, and *Apartheid's Reluctant Uncle: The United States and Southern Africa in the Early Cold War.* Borstelmann is writing a book about the United States and the world in the mid-1970s. The book will focus on issues of democratic and anti-colonial reform, the spread of feminism, environmentalism and the resurgence of religious faith and its impact on American politics. It will also focus on how Americans of this era thought about and engaged the world.

Borstelmann joined UNL in 2004 as the Elwood N. and Katherine Thompson distinguished professor of modern world history.

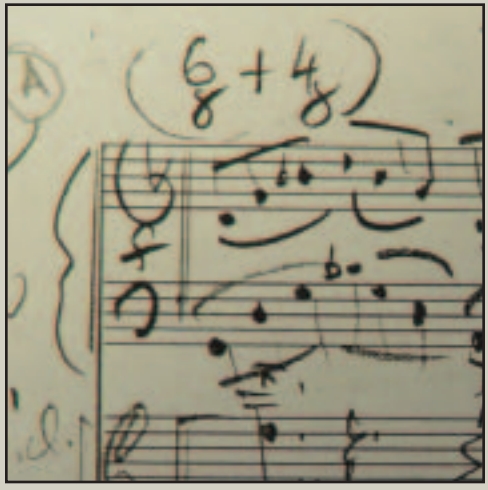
## IMLS Grant Funds Sculpture Conservation

Six landmark sculptures in UNL's Sheldon Memorial Art Gallery and Sculpture Garden will undergo conservation work funded by a $50,000 grant from the federal Institute for Museum and Library Services. "Willy" by Tony Smith; "SANDY: in Defined Space" by Richard McDermott Miller; "Nanticoke" by Robert Murray; "Floating Figure" by Gaston Lachaise; "Greenpoint" by Richard Serra; and "Fragment X-O" by Juan Hamilton were identified as high priorities by a conservator who assessed the works. The two-year project will begin in fall 2004, and includes landscape adjustments, staff training in conservation and maintenance, new labels for all the outdoor pieces and a new visitors' guide to the outdoor sculpture garden. The entire initiative has a budget of $121,000, with additional support from the Schweser Endowment Fund for Conservation at the University of Nebraska Foundation and members of the Nebraska Art Association.

Paul Barnes

# Commission with Philip Glass Commemorates Lewis & Clark Journey

Pianist Paul Barnes met Philip Glass by chance in 1995 when the two were on the same plane flying from Lincoln, Neb., to Chicago. Barnes had interviewed at the University of Nebraska-Lincoln for a spot on the music faculty. Glass had directed a performance of one of his works at the Lied Center for Performing Arts. A conversation began, and from it, an artistic collaboration ensued.



Barnes won that faculty position and soon found himself transcribing the composer's theater works for the piano. Transcriptions have a rich tradition in music. Composers' works often are transcribed to be played by solo instruments or small groups of instruments. Glass is one of the most widely performed contemporary American composers and is particularly well-known for his film scores. Barnes has completed and performed a number of Glass transcriptions and has recorded several.

Barnes was eager to move to the next step in their professional relationship – commissioning a new Glass composition for the piano. The Bicentennial of the Lewis and Clark Expedition piqued both their interests. Glass was intrigued by the challenge of presenting both Euro-American and Native American perspectives in a single work.

The Nebraska Lewis and Clark Bicentennial Commission, the Lied Center and UNL's Hixson-Lied College of Fine and Performing Arts funded the commissioning.

The concerto is written in the traditional three movements. The second movement debuted in midsummer at Nebraska's Lewis and Clark Bicentennial Signature Event, "First Tribal Council," which was performed outdoors in Omaha by Barnes and R. Carlos Nakai, Native American flutist.

The world premiere of the entire work, *Piano Concerto No. 2 (After Lewis and Clark)*, occurred on Sept. 18, 2004, with the Omaha Symphony at UNL's Lied Center with Barnes and Nakai as featured soloists with Glass in attendance. The work also will be performed in Omaha, Boston and Seattle.

# Harmonizing Energy Efficiency and Lighting Quality

Kevin Houser

UNL lighting engineer Kevin Houser is working to fine-tune the radiant energy spectrum of artificial light sources to get the strongest visual response at the lowest possible wattage. With funding from the California Energy Commission, Houser is seeking to harmonize energy efficiency and lighting quality. His goal: to bring a new, highly efficient light source to market. General Electric already is fabricating the lighting prototypes developed at Houser's lab at UNL's Peter Kiewit Institute in Omaha. Experts who viewed identical mock offices lit by conventional lamps and by Houser's prototypes preferred the experimental lighting. More efficient lighting is critical to reducing energy consumption – lighting makes up 26 percent of the nation's energy consumption in commercial buildings, and 6 percent in residences. Houser's lighting is estimated to be up to 20 percent more efficient than other new technologies.

## Just What Makes Those Huge Thunderstorms?

Giant thunderstorms, properly called mesoscale convective systems, fascinate meteorologist Matthew Brown Parker, who has won a National Science Foundation CAREER award to study what controls, organizes and maintains these storms. Hundreds of miles long, these systems are long-lived and particularly dangerous as they spawn dozens of storms and produce flash floods. In the Great Plains, these large storms produce 60 percent to 70 percent of the rainfall during the growing season, making them important players in the region's water balance.

Matthew Brown Parker

"They cast a huge footprint of severe weather and are almost a nightly process on the Great Plains in the spring and summer," Brown Parker said. Yet despite their importance and frequency, relatively little is known about them, he said. These storms have three typical structures, and Brown Parker will focus on two that are the least studied. Using super-computer models, he hopes to explain the key environmental and storm-scale processes that lead to these types of storms and look at how atmospheric situations affect them. The ultimate goals are to improve forecasting, giving people several hours of warning as opposed to the current 60-minute or less window of warning, and to increase public awareness of flooding and other threats from these storms, so the public is more likely to pay attention to weather information.

Brown Parker also will develop a high school curriculum that will enhance meteorological education and help recruit students to the discipline.

# Designing Profiling Techniques to De-Bug Software

Commercial software is extensively tested before it's released. But despite engineers' best intentions, software failures are common in the field. Computer scientist Sebastian Elbaum is looking for ways to continually test software by utilizing field data to improve software quality and reduce the number of bugs.


Sebastian Elbaum

Elbaum uses the metaphor of the "near-sighted engineer" to explain the problem. Engineers have an idea of what users want, he said, but there is no typical user or use of software. Every user's context is different – different brands of computers, different programs running, different printer drivers, different connections all combine to make each user and context unique. It is impossible to test for every situation.

In work supported by a CAREER grant from the National Science Foundation, Elbaum has designed a set of profiling techniques to capture field data from each potentially unique user and context, and use that data to develop better testing activities to improve the quality of a program. As part of an experiment to evaluate these techniques, thousands of users will be asked to use a piece of web-browser software that will report back to his team and profile how the software is being used. With thousands of users creating myriad data points, Elbaum is hoping to detect patterns of use that will close the loop between software that's been released and the continuous testing process.

## Active CAREER & K Awards

**National Science Foundation CAREER Awards**

- Stephanie Adams, Industrial and Management Systems Engineering
- Donald Becker, Biochemistry
- Matthew Brown Parker, Geosciences
- Berthe Choueiry, Computer Science and Engineering
- Bernard Doudin, Physics and Astronomy
- Sebastian Elbaum, Computer Science and Engineering
- Gustavo Larsen, Chemical Engineering
- Diandra Leslie-Pelecky, Physics and Astronomy
- Guillermo Orti, Biological Sciences
- Lance Perez, Electrical Engineering
- Stephen Scott, Computer Science and Engineering
- Lily Wang, School of Engineering Technology

**National Institutes of Health K Awards**

- Peter Angeletti, Biological Sciences
- David DiLillo, Psychology
- Kimberly Tyler, Sociology

# Wireless Technology Moves Robotic Traffic Barrels

Shane Farritor

They look like the familiar orange highway barrels that line miles of construction zones, but mechanical engineer Shane Farritor's robotic barrels respond to computer commands by moving in any direction and at different speeds. Farritor replaced the black rubber barrel bottoms with two motors and two drive wheels, a small computer and a wireless transceiver, creating a working highway robot. Farritor said the barrels could increase safety for highway workers and make it easier for the barrels to be moved after construction is completed.

The barrels can be randomly placed at the side of a road, remotely commanded to close a lane, and moved out; at the end of the day they can be called back in. Another use: create a moving wedge of barrels to follow and protect a moving work crew. This avoids having to drop, move and pick up barrels during the day.

Farritor, two graduate students and UNL computer scientist Steve Goddard began development of the robotic barrels in 2002 with a grant from the National Academies of Science IDEA program, established to fund innovative ideas in highway research. The prototype barrels cost $700 each, but Farritor believes the cost can be cut to $200 each. He has applied for a patent on the barrels and is exploring new uses.

"The barrels get hit on the highway, so we want them to be cheap, which means they're dumb," Farritor said. To get around this problem, Farritor has used a shepherd/sheep arrangement, where a single expensive, intelligent shepherd robot stays on the side of the road and gives commands to send the others – the sheep – into traffic. "And the highway workers stay out of harm's way," Farritor said.

# Buffalograss Varieties Licensed to Nebraska Grower

Homeowners and businesses will have access to a unique native turfgrass through an exclusive licensing arrangement between UNL and Todd Valley Farms, based in Omaha, Neb. Todd Valley Farms received an exclusive license for the Legacy® and NE-91-118 varieties of buffalograss, developed by UNL turfgrass scientists. Legacy® has a narrow, soft blade and darker green color than other buffalograsses, yet is still low maintenance and drought tolerant, making it an ideal turf for residential and commercial lawns. UNL's turfgrass team, headed by turfgrass breeder Terrance Riordan, is a national leader in buffalograss research and development. Todd Valley Farms is one of the few growers in the country that vegetatively produces turf-type buffalograss.

# Cellulose from Cornhusks Yields Textile-Grade Fiber

Nebraska's biggest crop, corn, produces a lot of waste in cornhusks. Textile scientist Yiqi Yang has developed a process to convert the cellulose in husks into fibers that could be spun into yarn and woven into fabric. UNL is patenting his invention, which he hopes will be commercialized.

Yiqi Yang

Yang uses an inexpensive and efficient chemical technique to extract and purify the fibers. Cellulose, the main constituent of all plant tissues and fibers, is the polymer in cotton, linen and rayon.

The United States produces 20 million tons of cornhusks annually, which could create 2 million tons of fiber with a $2 billion value. Although the amount of fiber needed to create a garment varies by the garment's size and design, it takes about three pounds of cornhusks to make an average T-shirt.

"The textile industry is a huge market, so if we can find an application in textiles, we don't have to worry about finding a market. Just one application could have a big impact on agriculture," Yang said.

# Undergraduate Research Programs Under Graduate Studies' Watchful Eye

Summer Research Program Participants

UNL's Office of Graduate Studies coordinates two programs that offer intensive summer research opportunities to undergraduates, particularly students of color, under-represented students or first-generation college students.

The Summer Research Program recruits scholars from historically black colleges and universities, and regional and national universities to participate in either the Summer Undergraduate Research Opportunities Program in biological sciences funded by the National Science Foundation through Nebraska EPSCoR or the Ronald E. McNair Post-Baccalaureate Achievement Program funded by a four-year, $1 million grant from the U.S. Department of Education.

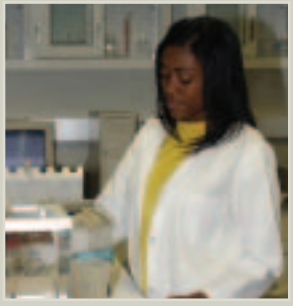
SUROP scholars spend eight weeks on campus participating in an intensive, mentored research experience. The 2004 Summer Research Program brought 32 scholars from 14 schools for research in disciplines ranging from redox biology to English to chemical engineering. In addition to their 36-hour research week, scholars attend graduate school preparation seminars led by UNL faculty and participate in an interactive GRE Prep course that includes symposium presentations and attendance at the Indiana State McNair Research Conference.

UNL's McNair program serves 25 low-income, first-generation or underrepresented students in intensive two-year cohorts designed to prepare upper-level under-graduates to complete the baccalaureate degree, enroll in graduate education and complete a doctoral degree.

McNair Program scholars attend a summer session filled with personal and professional development seminars and high-quality research experiences and are given guidance in applying to graduate school in the year following their summer experience.

Richard Anceta

Caronda Moore



Tiera Gilder

# Grad Students Receive Professional Development Opportunities

New academic, career development and instructional development workshops offered by the Graduate Student Academic & Professional Development Program in 2004 attracted more than 350 graduate student participants. These programs supplement graduate students' preparation in their home departments and offer integrated professional development activities.

*Academic Development* includes workshops on time management, publishing, grant writing, technical report writing and the ethical conduct of research.

*Career Development* prepares graduate students for their profession. An example is the Preparing Future Faculty Program, a national initiative to transform graduate education, that was integrated into the Office of Graduate Studies in 2004. Twenty-two fellows are enrolled and will be mentored by faculty from six partner institutions.

*Instructional Development* supports graduate teaching assistants through an orientation program, an institute for international teaching assistants, collaboration with academic departments to provide discipline-specific training and supervised teaching experiences. The program's staff also works with departments to develop research-training opportunities for training grants.

## UNL to Develop Interactive Economics Instruction

More than 100,000 undergraduate economics students nationwide will benefit from more interactive teaching strategies developed through a project directed by UNL economist William Walstad. The five-year, $675,000 National Science Foundation-funded project aims to help 500 college faculty throughout the United States incorporate interactive learning practices and technologies into their classrooms.

Bill Walstad

Research shows that most economics curricula are lecture-based and students could benefit from more interactive teaching strategies. Faculty participating in the project will learn new teaching strategies in three phases. In phase 1, faculty will work in teams in workshops and seminars to learn about interactive strategies and materials. In phase 2, participants return to their institutions and receive on-line instruction in new classroom teaching techniques. During Phase 3, participants will join a community of teaching scholars to share experiences, present papers on teaching and learning and participate in conferences and seminars. The Committee on Economic Education of the American Economic Association is a project co-sponsor.


James Van Etten


Gary Moulton

# The Nebraska Lectures

The Nebraska Lectures: Chancellor's Distinguished Lecture Series in 2003-04 featured an eminent virologist and a nationally known historian. The series recognizes UNL faculty who have made significant scientific and scholarly contributions.

James Van Etten, the Allington Professor of Plant Pathology and a National Academy of Sciences member, delivered an Oct. 30 lecture titled "The Unusual Lifestyle of Giant Algal Viruses." Van Etten spoke about viruses in general and specifically about the family of viruses he and a colleague discovered in 1981. Members of this family, called *Phycodnaviridae*, are among the most genetically complex viruses ever found. These viruses have about 375 genes; in comparison, HIV contains 12 genes.

Gary Moulton, Sorensen Professor of American History, presented "Sampling Lewis and Clark: Selected Readings from the Journals and Discussion of Events in Context" on March 30. Moulton's 13-volume *The Journals of the Lewis and Clark Expedition* – the most accurate and inclusive edition ever published – took 20 years to edit and is one of the major scholarly achievements of the late 20th century. The series was published by the University of Nebraska Press. A 14th book, an abridged edition that condensed some 5,500 journal pages into one volume, was published in 2003.

The Nebraska Lectures are sponsored by the UNL Research Council, the Office of the Chancellor and the Office of Research and Graduate Studies.

## Research Fair 2004 Links Faculty, Program Officers

UNL celebrated research and scholarly activity during its second annual Research Fair April 21-23. Research Fair 2004 included informative workshops for graduate students and faculty, recognized faculty research awards, highlighted books written by UNL faculty published in 2003 and featured sessions by the following federal agency representatives: Bianca Bernstein, director, NSF Division of Graduate Education; Robert Croyle, director, Division of Cancer Control and Population Sciences, NIH National Cancer Institute; Minoo Dastoor, NASA Office of Aerospace Technology; Monica Neagoy, program director, NSF Elementary, Secondary and Informal Education; T.D. Waite, program director, NSF Division of Bioengineering and Environmental Systems; George Wilson, legislative specialist, NSF Office of Legislative and Public Affairs.

The Research Fair is designed to inform faculty of federal agencies' funding priorities and opportunities, to foster multi-disciplinary collaboration and to disseminate the university's research endeavors.

North Platte River at Bayard, Nebraska

# Inaugural Water Conference Connects Scientists, Scholars, Policymakers

The complex issues involved in reaching water resources management decisions that meet the needs of all stakeholders were addressed by national and international experts at UNL's inaugural Water Law, Policy and Science Conference, "Finding Solutions to Multi-jurisdictional Water Conflicts."

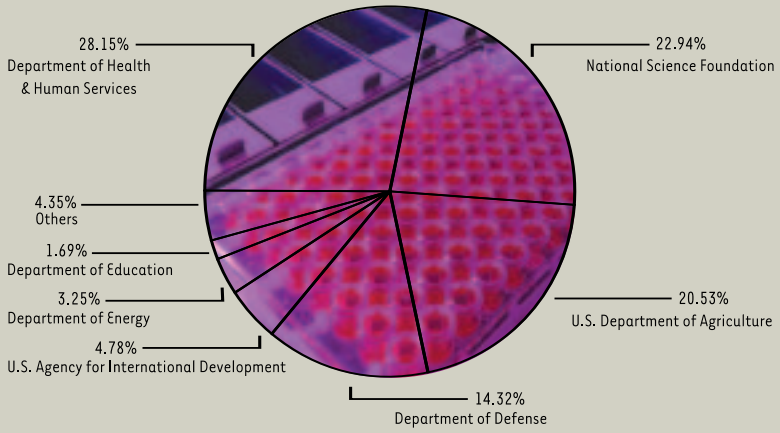
Sandra Postel, director of the Global Water Policy Project, opened the March 4-5 conference with an address on "Water for Life: Rethinking Management in an Age of Scarcity." Other keynote speakers included Joseph Sax, noted water and environmental law professor and Order of the Coif Distinguished Scholar at the University of California-Berkeley, and Robert Glennon, Morris K. Udall Professor of Law and Public Policy at the University of Arizona.

"A major goal of the conference is to foster ongoing dialogue and collaborative research among legal experts, scientists, engineers, economists and other disciplines to better understand the oftentimes competing ecological and human needs for water and to reach sustainable management solutions," said Sandi Zellmer, UNL law professor and conference organizer.

The conference will continue as an annual venue for leading experts to discuss different legal, scientific and policy aspects of water issues.

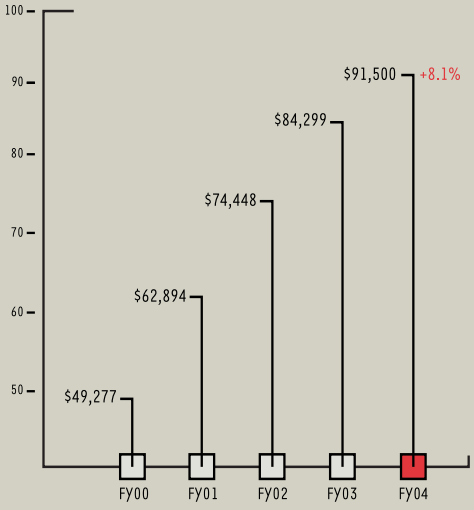
## Research Funding by Federal Agency

(in Millions)



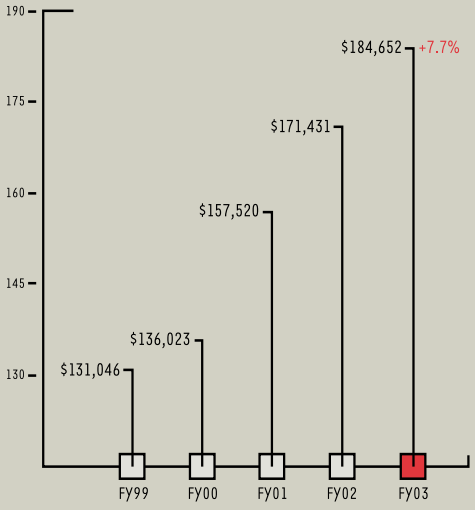

## Five-Year Total Research Awards

(in Millions)




## Five-Year Total R&D Expenditures

(in Millions)



# Credits

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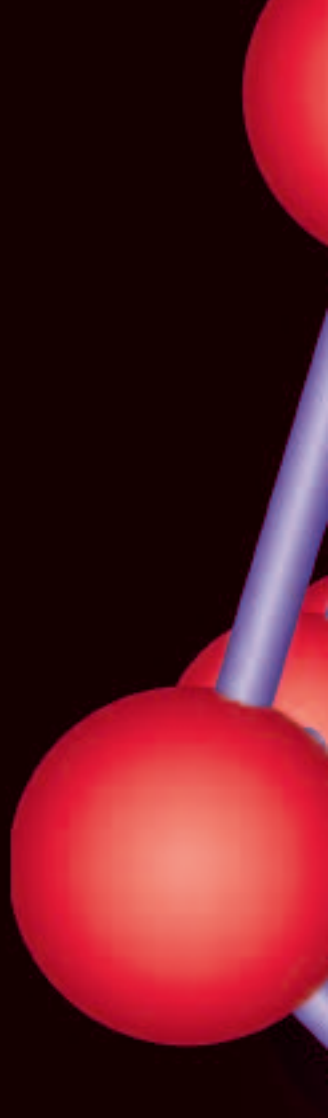

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