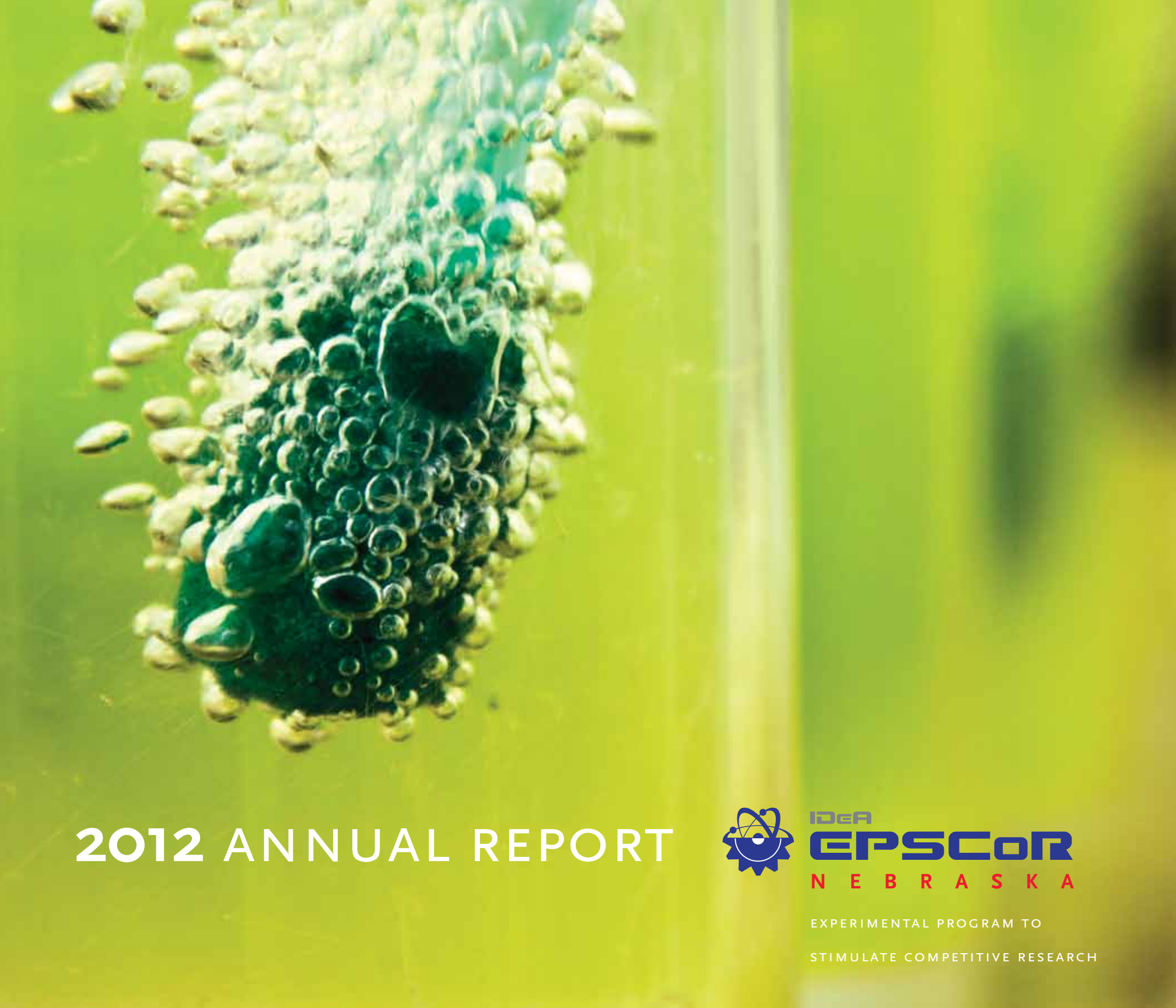


2012 ANNUAL REPORT

IDeA EPSCoR NEBRASKA

EXPERIMENTAL PROGRAM TO STIMULATE COMPETITIVE RESEARCH

IDeA EPSCoR NEBRASKA

Experimental Program to Stimulate Competitive Research
Institutional Development Award Program

Nebraska EPSCoR
W192 Nebraska Hall
Lincoln NE 68588-0557

Phone: 402-472-8946
Fax: 402-472-8948
https://epscor.nebraska.edu

Nebraska EPSCoR Staff
F. Fred Choobineh, PE, PhD, Director
Sarah Zulkoski, Outreach Coordinator
Nancy Simnitt, Administrative Technician
Hanna Day-Woodruff, Communications Specialist
Fred Gartner, Accounting Technician

EDITOR: Hanna Day-Woodruff
GRAPHIC DESIGNER: Nathan Putens

Contents

Cover: A close-up of an aerator in algae-filled water. *Inside cover:* A close-up of algae tanks. George Oyler, research associate professor of biochemistry at the University of Nebraska-Lincoln, and member for the Nebraska Coalition for Algal Biology and Biotechnology, is exploring ways to grow algae for biofuels.

Director's Message

F. Fred Choobineh, director of Nebraska EPSCoR, is the Blackman Distinguished Professor of Engineering at the University of Nebraska–Lincoln.

BUILDING THE research capacity of the state and increasing its competitiveness are primary objectives of the Nebraska EPSCoR program. One of our strategies is to foster an ecosystem of collaboration by creating interdisciplinary teams of researchers capable of competing for federal funds in emerging areas of research. Transdisciplinary neuroscience research is emerging as a well-funded research area, and we are positioning Nebraska researchers to take advantage of future opportunities.

Neuroscience encompasses the search to understand complex neurobiological systems, from genetic determinants to cellular processes, to the complex interplay of neurons, circuits, and systems that orchestrate behavior and cognition. Several Nebraska institutions have neuroscience programs, but at the moment no overarching collaborations connect them. Federal funding trends, however, are towards large-scale projects that transcend the traditional disciplinary boundaries in pursuit of research with transformative potential.

Through the Transdisciplinary Research Cluster Award, a program initiated in 2012, Nebraska EPSCoR awarded $300,000 to a team of neurochemists, pharmacological neuroscientists, and developmental physiologists who are seeking the molecular mechanisms of neural plasticity. These researchers are at Creighton University, Boys Town National Research Hospital, and the University of Nebraska Medical Center. In addition, we have issued a call for proposals for a Transdisciplinary Neuroscience Research Seed Grant for up to $150,000 per project. And on October 3, 2013, neuroscience will be the focus of the Nebraska Research and Innovation Conference in Omaha.

We are excited about facilitating a broader ecosystem for neuroscience research, and we believe our leadership role will enhance Nebraska's future competitiveness.

NRIC 2012: The Nanosciences Symposium

SCIENTIFIC RESEARCH at the nano scale is transforming our day-to-day world, advancing fields as diverse as computing, medicine, and energy technologies. With Nebraska emerging as a hub for nano-related research, nanosciences was a natural topic for the 8th Nebraska Research and Innovation Conference, held in Lincoln in October. The Symposium featured presentations from leading nanoscientists from around the world, and included broad overviews on recent advancements and tracks on nanomaterials preparation, catalysis, novel nanoelectronics, and biosensing applications. The Symposium highlighted state-of-the-art nanomaterials research and engineering in Nebraska and attracted over 200 attendees, including researchers, graduate and undergraduate students, and members of industry.

Pat Dussault, co-director of the Center for Nanohybrid Functional Materials and one of the event organizers, remarked that the conference attracted an "incredibly strong" group of presenters and benefitted from robust participation of the Nebraska nanoscience community. Plenary speakers included **Karen Wooley**, Texas A&M University, who focuses on nano drug delivery devices; **Chang-Beom Eom**, University of Wisconsin-Madison, who shared his research into oxide nanoelectronics; **Akhlesh Lakhtakia**, Pennsylvania State University, who discussed sculptured thin films; and **James M. Tour,** Rice University, who discussed his research into carbon nanocars.

The morning and afternoon symposia tracks were attended by large and enthusiastic audiences. However, Dussault also noted that, "the formal presentations were only part of the story; much of the success of the event came from the opportunity for interaction among nano-science-related researchers." He commented that the poster session had been particularly effective in this regard, with several of the visiting speakers going out of their way to praise the caliber of research in the state.

A half-day of professional development talks preceded the Symposium and provided students with insights on crafting effective resumes, conduct during interviews, and perspectives on science careers in and beyond academia.

Major Nanoscience Grants:

NSF: Materials Research Science and Engineering (MRSEC) QSPIN at the University of Nebraska–Lincoln

NSF EPSCoR: Nebraska Center for Nanohybrid Functional Materials, involving faculty from University of Nebraska–Lincoln, University of Nebraska at Kearney, Creighton University, Doane College, and University of Nebraska Medical Center

NIH IDEA: COBRE Nebraska Center for Nanomedicine at the University of Nebraska Medical Center

NSF EPSCoR: a Track 2 grant supports MRSEC researchers in collaboration with researchers from Puerto Rico to create nanotechnologies to support energy efficient electronics and fuel cells.

(*Above*) The Nanosciences Symposium attracted some of the world's leading nanoscientists. (L–R) **Mathias Schubert**, University of Nebraska–Lincoln and co-director of the Nebraska Center for Nanohybrid Functional Materials (organizer); **James Tour**, Rice University; **Akhlesh Lakhtakia**, Pennsylvania State University; **Karen Wooley**, Texas A&M University; **Chang-Beom Eom**, University of Wisconsin-Madison; and **Evgeny Tsymbal**, director of the Materials Research Science and Engineering Center at the University of Nebraska–Lincoln (organizer).

(*Right*) An illustration of variable diameter carbon nanotubes based on the research by **Yongfeng Lu,** Lott University Professor of Electrical Engineering at the University of Nebraska–Lincoln, and his team. This illustration won honorable mention in the 2012 International Science and Engineering Challenge. Joel Brehm/UNL Office of Research and Economic Development

The Cyberinfrastructure Improvement Yield

"The increased bandwidth immediately improved distance education, facilitated multi-institutional collaborations, and spurred other infrastructure improvement projects"

Total EPSCoR investment: $1.32 million

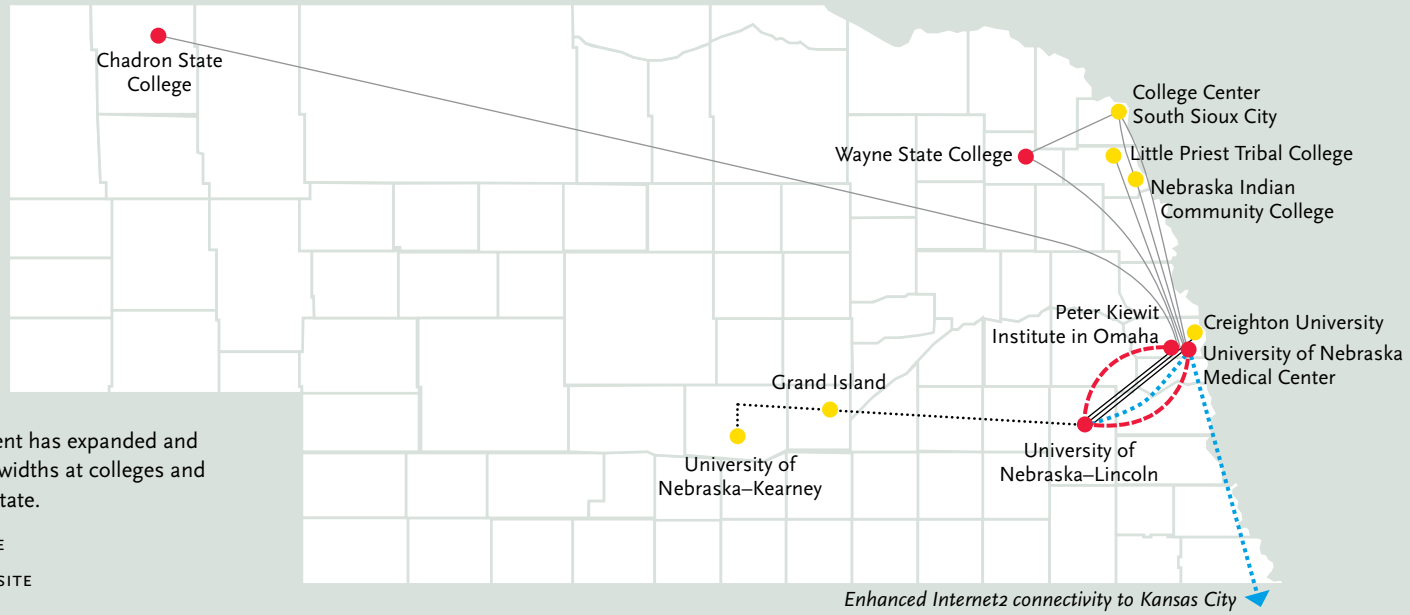
2012 WAS the final year of the EPSCoR Track C2 Award to expand cyber-infrastructure throughout the state. Awarded in 2010 from stimulus funds, the project set out to complete Phase I of a multi-phase plan spearheaded by the University of Nebraska to upgrade the internet connections of many of the state's small and tribal colleges and the high-bandwidth connections for the state's research universities. These connections immediately improved distance education, facilitated multi-institutional collaborations, and spurred other infrastructure improvement projects.

The NEURON is the Nebraska University Regional Optical Network, a fiber optic backbone ring that originally connected the University of Nebraska-Lincoln to the Peter Kiewit Institute and the University of Nebraska Medical Center in Omaha. Those connections were upgraded from 10 gigabits to 30 gigabits, and Creighton University was connected to NEURON with a new 10 gigabit fiber, enabling advanced computational collaborations for high energy physicists and other researchers.

Wayne State College, in northeast Nebraska, was connected to NEURON through a 1 gigabit fiber, and an additional 300 megabit fiber was connected to a second campus, College Center. The College Center campus in South Sioux City is a collaborative higher education location combining the teaching/coursework from Wayne State College and Northeast Community College.

For Wayne State College, the increased bandwidth has had a cascade of benefits, improving the quality of access to the student information and human resources systems and making possible the installation and utilization of a

Nebraska University Regional Optical Network (NEURON)



A $1.32 million investment has expanded and upgraded network bandwidths at colleges and universities across the state.

- NETWORK PRIMARY SITE
- NETWORK SECONDARY SITE

small super-computer cluster. The cluster will allow students to gain experience in parallel computing and management, and could lead to participation in the Open Science Grid.

Through this grant, Nebraska's tribal colleges received significant cyberinfrastructure upgrades. New 100 megabit high speed connections to NEURON became possible with the installation of new fiber cable for Little Priest Tribal College in Winnebago and Nebraska Indian Community College's campuses at Macy and South Sioux City.

The tribal colleges have already capitalized on the opportunities afforded by greater internet bandwidth. Little Priest Tribal College (LPTC) expanded distance course offerings to its students and now offers joint classes with instructors at other universities. LPTC and the Nebraska Indian Community College (NICC) established radio stations; LPTC streams content to a nearby tower for broadcast. The increased bandwidth significantly improved the experience of NICC students who participate in their Video TeleConference systems and allowed the college to teach 90% of its courses on line.

The final component of the grant is the westward expansion of the high bandwidth capability to the Grand Island hub where it serves multiple western Nebraska educational institutions. This investment will soon make the University of Nebraska at Kearney connected to NEURON through a high throughput fiber.

The critical cyberinfrastructure installed from this grant enabled partner institutions to undertake upgrades of their own, including upgrades at Chadron State College and at over 200 K-20 sites across the state. Future phases of this project will reach small and community colleges in the central and western part of the state, as well as the Nebraska Statewide Telehealth Network.

The total EPSCoR cyberinfrastructure investment in Nebraska has been $1.32 million.

FIRST Awards 2012

NEBRASKA EPSCoR is committed to supporting early-career faculty establish their research programs and be more competitive for National Science Foundation (NSF) awards. Since 2004, Nebraska EPSCoR's FIRST Award has offered a competitive grant program that provides $20,000 for research that could lead to the NSF's CAREER Award. The CAREER Award is NSF's most prestigious award for junior faculty. In addition to monetary support, Nebraska EPSCoR's FIRST Award provides expert preliminary reviews on applicants' CAREER proposals.

In 2012, one prior FIRST Awardee won a CAREER Award. **Xia Hong**, a 2011 FIRST Awardee in the University of Nebraska–Lincoln Physics Department, will use her 5-year, $600,000 CAREER award to create new ferroelectric nanomaterial for data storage devices.

2012 Awardees:

- Neural coding of closely-related stimuli: interplay of geometry and combinatorics; Principal Investigator (PI): **Carina Curto**, Mathematics, University of Nebraska–Lincoln (UNL).
- Aerial Robots for Scientific Sensing; PI: **Carrick Detweiler**, Computer Science and Engineering, UNL.
- Evolution of rRna Introns in Fungi; PI: **Dawn Simon**, Biology, University of Nebraska Kearney.
- Surface-induced protein conformational dynamics; PI: **Patricia Soto**, Physics, Creighton University.
- Unraveling Integrin dynamics using Turn-On Fluorescence Labels; PI: **Cliff Stains**, Chemistry, UNL.
- Colloidal synthesis of high-index faceted metal nanoparticles as efficient electrocatalysts; PI: **Jian Zhang**, Chemistry, UNL.

FIRST Awardee wins NSF CAREER Award

XIA HONG, an assistant professor of physics at the University of Nebraska–Lincoln and 2011 FIRST Awardee, won the prestigious CAREER Award from the National Science Foundation for her work on oxide nanomaterials and their unusual magnetic and electric properties. She will receive $600,000 over five years for her research.

Hong and other nanoscientists work with the principle that chemical compounds at the nanometer scale (one billionth of a meter) behave very differently than their larger, macro siblings. With the oxides she creates, it is possible to control magnetic information using electric power, a capability that can be used to develop computer and other electronics with higher storage capacity, faster operation speed, and lower power consumption.

"This approach offers a material solution to transcending the fundamental performance limits faced by today's silicon-based electronics," she writes.

CAREER Awards also include a teaching component that integrates with the research. Hong is creating cartoons about a young woman in high school as she considers whether to pursue an interest in physics.

For Hong, the FIRST Award proposal process was an excellent preparation for the submission of a CAREER proposal, because it required a draft CAREER proposal that received expert reviews. Hong writes, "Going through the proposal development stages guided by the FIRST Award was critical to the success of this [CAREER] proposal."

Launching Transdisciplinary Research Clusters

NEBRASKA EPSCoR'S mission is to improve the research capacity of the state, and in doing so, has been a leader in fostering collaborative research. Consistent with its "experimental" nature, Nebraska EPSCoR initiated an experimental funding program to encourage high-risk, high payoff transdisciplinary research.

This initiative is aligned with the strategic goal of the National Science Foundation to "Transform the Frontiers" of research. As stated in NSF's strategic plan, "The Foundation embraces our unique role in supporting the fundamental, interdisciplinary, high risk, and potentially transformative research and education that are central to the discovery of emergent properties and structure in physical, living, human and engineered systems." It is in this same spirit that Nebraska EPSCoR supports nascent research collaborations with transformative potential that transcend the boundaries of their disciplines.

The Transdisciplinary Research Cluster Award offered up to $300,000 for one to two years to new research groups with representation from multiple higher education institutions in the state. Twelve proposals were submitted and reviewed by experts. Two recipients were chosen by the Nebraska EPSCoR State Committee, a nineteen member group that includes senior administrators from the state's major research institutions, industry leaders, and representatives of state government.

Transdisciplinary Research Cluster Awardees

"Ferroelectric-enhanced organic electronics" a collaboration between physicists and mechanical engineers at the University of Nebraska–Lincoln and the University of Nebraska at Kearney. PI: Professor **Stephen Ducharme**, Department of Physics and Astronomy, UNL. $225,000

"Mechanisms of Neural Plasticity" a collaboration between neurochemists, pharmacological neuroscientists, and developmental physiologists at Creighton University, Boys Town National Research Hospital, and the University of Nebraska Medical Center. PI: Professor **Thomas Murray**, Department of Pharmacology, Creighton University. $300,000

Support for Undergraduate Research at Small Colleges and Universities

THE SMALL College Undergraduate Research Experience award provides faculty with up to $5,000 to fund undergraduate research projects in science, technology, engineering, and mathematics (STEM). Research budgets at Nebraska's smaller institutions are often limited, and this competitive Nebraska EPSCoR program offers students the excitement of scientific exploration and discovery. Student researchers are integrated into the project design and implementation and in some cases have contributed to publications. Participants are invited into the broader STEM community by presenting a poster at the annual Nebraska Research & Innovation Conference.

Four faculty received the award in 2012. They are: **John Hastings**, Computer Science, University of Nebraska at Kearney, $5,000; **Christopher Wentworth**, Physics, Doane College, $5,000; **David Peitz**, Chemistry, Wayne State College, $4,200; **Marilyn Petro**, Psychology Department, Nebraska Wesleyan University $4,984.

IDeA in Nebraska: Biomedical Research and Education

THE INSTITUTIONAL Development Award (IDeA) is a program of the National Institutes of Health to broaden the geographic distribution of the NIH biomedical and behavioral research funds. It operates through Centers of Biomedical Research Excellence (COBRE) and the IDeA Networks of Biomedical Research Excellence (INBRE).

Current Nebraska IDeA Awards:

The Redox Biology Center
University of Nebraska–Lincoln and the University of Nebraska Medical Center
$10.8 million, August 2007-August 2012

Nebraska Center Drug Delivery and Nanomedicine
University of Nebraska Medical Center
$10.65 million, September 2008-June 2013

Nebraska Center for Cellular Signaling
University of Nebraska Medical Center
$9.8 million, July 2008-June 2013

Nebraska Center for the Molecular Biology of Neurosensory Systems
University of Nebraska Medical Center
$10.2 million, September 2009-June 2014

Nebraska INBRE Program
University of Nebraska Medical Center
$18.0 million, May 2008–June 2014

NSF EPSCoR Track 1 Update

IN 2010, Nebraska EPSCoR was awarded the prestigious NSF EPSCoR Track 1 Award for $20 million over five years to establish two centers of research: the Nebraska Center for Nanohybrid Functional Materials and the Nebraska Coalition for Algal Biology and Biotechnology. Both centers transitioned from their second to third years in 2012 with significant advancements.

Nebraska Center for Nanohybrid Functional Materials

The Nebraska Center for Nanohybrid Functional Materials (CNFM), comprised of 17 researchers from five colleges and universities, marked significant progress towards its major research goals, which focus on discovering and applying new sensing and detecting principles using hybrid nanomaterials. The center also advanced its efforts to sustain the research beyond the Track 1 Award by setting bold long-term goals, attracting strong new investigators through an experimental seed funding program, and securing additional external grants. To follow on the renovations of the core facility that were completed in 2011, the Center welcomed its first core facility director, **Rafal Korlacki**, an electrical engineer with expertise in optics, spectroscopy and spectroscopic ellipsometry. The Center awarded seed funding to four new investigators whose research aligns with the Center. Center investigators contributed to Young Nebraska Scientist (YNS) summer nanoscience camps and mentored high school researchers, who gained first-hand experience in center labs through summer paid internships. A panel of external expert reviewers described the achievements of CNFM in its second year as "impressive."

Nebraska Coalition for Algal Biology and Biotechnology

Microalgae have recently gained recognition as feedstocks for renewable biofuel production but key advances in our understanding of algal biology are needed to achieve commercial feasibility. To this end, the Nebraska Coalition for Algal Biology and Biotechnology (NCABB) is focused on gaining basic knowledge of algal biomass production and its partition into suitable biofuel precursors such as lipids. This multidisciplinary group of 14 researchers has made important investments in state-of-the-art equipment, algal growing facilities, and new faculty to expand research capabilities at three Nebraska universities. A new hire, **Wayne Riekhof**, assistant professor in the School of Biological Sciences at UNL, has added his expertise in lipid metabolism in eukaryotic organisms. Team members are: defining the molecular components involved in carbon dioxide uptake and assimilation by algae; isolating improved strains for biomass accumulation and lipid production; exploring algal culture systems; characterizing lipid metabolism at the enzymatic and regulatory levels under nutrient deprivation conditions; screening for small chemical compounds that may affect oil production; and identifying algal pathogens that may limit productivity. Raman spectroscopy imaging approaches to monitor neutral lipid accumulation and GC-MS and LC-MS methods for the analysis of a variety of lipids are also being developed. Investigators integrated research and teaching through YNS summer science camps focused on algal biology.

WAYNE RIEKHOF is an assistant professor in the School of Biological Sciences at UNL. He completed his doctorate at Michigan State University, and came to UNL after a postdoc at National Jewish Medical and Research Center in Denver. His research focuses on using microbial eukaryotic model organisms as systems to study various aspects of lipid metabolism, including membrane lipid and fatty acid trafficking between organelles, the regulation of membrane lipid and triglyceride synthesis, and the regulation of lipid droplet assembly and morphology.

Spotlight on Nanoscience Postdocs

THE NEBRASKA Center for Nanohybrid Functional Materials (CNFM) is a large collaboration of researchers from across the state working to harness the unique properties of nanomaterials for sensing and separation devices. All postdoctoral researchers are assigned two faculty mentors and are supported in their efforts to collaborate within the CNFM community and develop skills necessary for their future careers. CNFM provides regular seminars for its members and organized a professional development workshop for students and postdocs at the Nanosciences Symposium in October.

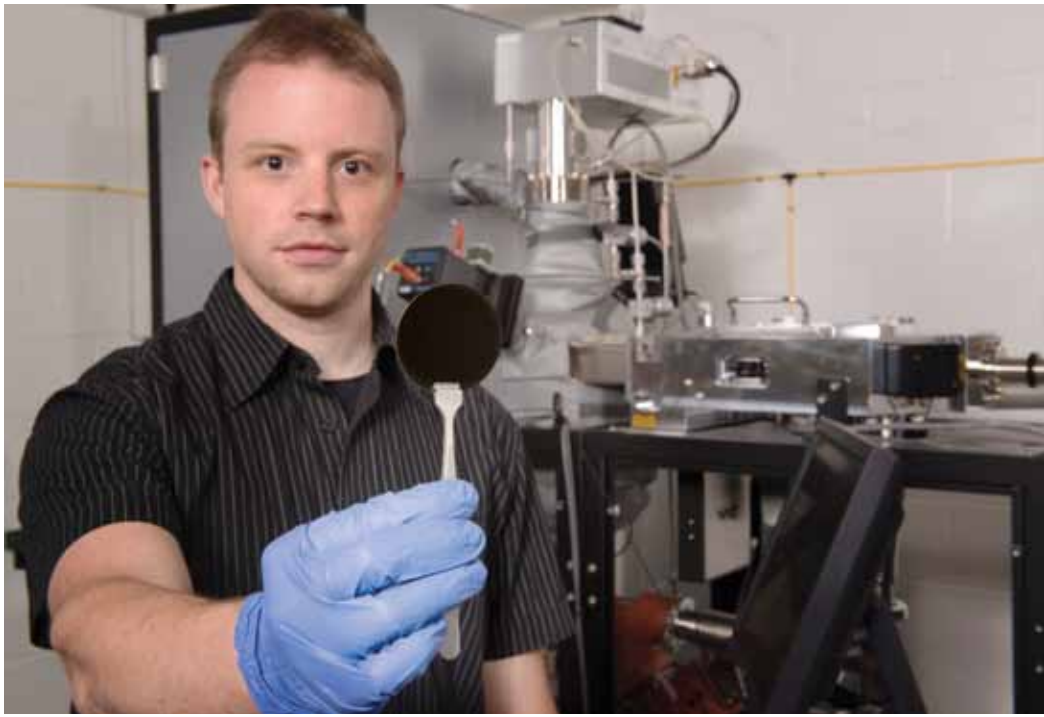
"The most rewarding aspect of mentoring postdoctoral fellows during the transition from student to professional is to develop and promote their skills in order to qualify for positions they seek and become leaders in their field!" writes **Andrea Holmes**, an executive member of the CNFM management team and associate professor of chemistry at Doane College in Crete. Highlighted below are three of the postdocs participating in CNFM who are funded through the 2010 NSF EPSCoR Track 1 award.

SHARMIN SIKICH received her doctoral degree in Chemistry from the University of California San Diego and is now working as a postdoctoral researcher in the Holmes' lab at Doane; UNL professor **Mathias Schubert** serves as a second mentor. The lab is working on the DETECHIP, a device that allows for the simultaneous detection of multiple chemical compounds in a complex mixture, such as blood, saliva, or water. DETECHIP can be used to detect specific legal and illegal pharmaceuticals, explosive residues, or environmental contaminants. Sikich is helping with the miniaturization of the device and its commercialization, while also managing Holmes' undergraduate researchers, teaching biology and chemistry classes, and coauthoring three publications in the last year. She and her colleague, **Macduff Okuom**, are planning a nanoscience summer camp for 2013, and in March, she will present a poster at the Third Conference on Multifunctional, Hybrid and Nanomaterials in Sorrento, Italy. She is looking for a tenure-track position in a small to medium sized college or university. She writes, "Working with CNFM has provided me with an opportunity to gain knowledge in areas I had not previously known…I have learned techniques and lab ideas in nanoscience that I can also incorporate into my college courses."

"Through the collaborative approach between engineering, materials science, physics, and chemistry, we learn so much from each other."

MACDUFF OKUOM received his doctoral degree in chemistry from the Missouri University of Science and Technology with a focus on polymer physical chemistry. As a postdoctoral researcher of chemistry in the Holmes lab at Doane, he also works on the DETECHIP, teaches undergraduate chemistry classes, and is preparing a manuscript for publication. His goal is to teach and research at the college level. Schubert also serves as his second mentor.

Okuom writes, "CNFM has provided me with a great opportunity to participate in scientific research on nanohybrid materials. I appreciate the CNFM sponsored seminars, the career workshops, and the opportunity to present my research at conferences."



DANIEL SCHMIDT received his doctoral degree in electrical engineering from the University of Nebraska–Lincoln in 2010 and stayed on as a postdoctoral researcher in the labs of **Mathias Schubert** and **Eva Schubert**. His current research focuses on sculptured thin films and the characterization of their optical and magneto-optical properties, as well as their sensing device applications. Schmidt has consistently won research awards, most recently the Topical Focus Ellipsometry Session Prize at the AVS International Symposium in 2011. He has published 16 articles, two book chapters and submitted two patent applications. Schmidt's goal is to have a flourishing private industry career.

"I truly enjoy working as part of the CNFM team in this interdisciplinary field of hybrid nanostructures and their applications. Through the collaborative approach between engineering, materials science, physics, and chemistry, we learn so much from each other. The daily tasks are always exciting, challenging yet fun—and it never gets boring since there are so many different things to do!"

Tackling Traumatic Brain Injuries with Nanoscience

David Hage, Hewett University Professor of Chemistry at the University of Nebraska-Lincoln

WHEN A football player receives a serious blow to the head during a game and a concussion is suspected, there's no on-field test device for a traumatic brain injury (TBI). At least, not yet. **David Hage** is working to change this by creating a device that can be used to immediately determine whether a traumatic brain injury has occurred, and if so, how severe it is.

In 2012, Hage, the Hewett University Professor of Chemistry at the University of Nebraska–Lincoln and member of the Nebraska Center for Nanohybrid Functional Materials (CNFM), began a partnership with Arkansas-based SFC Fluidics to develop such a device for the commercial market. The device will use antibodies that bind to proteins that the brain produces expressly as a result of a head trauma.

Hage uses high performance affinity chromatography (HPAC), a kind of biochemical trap, to detect the presence of such proteins. HPAC is a separation method in which a liquid sample, like blood, is passed through a tiny column that traps target molecules by latching them to binding molecules packed in the column. In the brain injury example, a sample of blood travels through a column packed with specific antibodies that latch onto the brain-injury protein. To determine the quantity of the protein in the sample, the column is then also injected with similar proteins that are labeled with a fluorescent dye and compete for the antibodies in the column. If brain-injury protein is present, the fluorescent-labeled protein will pass through the column unimpeded, and the fluorescent signal will be low. A higher fluorescent signal indicates a lower injury-protein count and a less severe injury. This method can both confirm a concussion diagnosis and indicate the severity of the injury, and can also be applied to look for a number of different substances: drugs, hormones, proteins, environmental contaminants, explosives…the list goes on.

"We take inspiration from nature by using biological receptors to recognize and detect chemicals in complex mixtures like blood," Hage said.

In terms of sensitivity, Hage expects to be able to detect and measure substances down to nanograms (one billionth of a gram), or, in the case of the proteins that signal a traumatic brain injury, down to picograms (one trillionth of a gram). Detecting one protein in a trillion other molecules is certainly a feat to boast, but chemical sensors in nature, such as the tongue or sense of smell, have a similar level of sensitivity. He says, "The sense of taste is based on the same principles that we use in our separation devices; the tongue uses proteins that recognize certain chemicals that then cause the receptor to interpret that as being a certain taste." His team has used nanohybrid particles as structural supports for the antibodies or proteins that are used to separate or detect.

The prototype device for TBI diagnosis is in development, and the target for commercialization is 2014. This research was supported in part from the $20 million, 2010 NSF EPSCoR Track 1 Award, which established CNFM, a coalition of Nebraska researchers from five colleges and universities working to harness nanohybrid molecules for novel separation and detection devices.

Unlocking the CO_2 Concentrating Mechanism in Algae

ALGAE ARE so prevalent in our environment, growing just about anywhere with water, air and sunlight, that they often are seen as a nuisance to eliminate rather than something to cultivate. But for plant scientists and those concerned with finding renewable fuel sources, algae are worthy of careful analysis and experimentation. This is because several varieties produce lipids that could be used as biofuel. **Don Weeks**, the Maxcy Professor of Agriculture and Natural Resources at the University of Nebraska–Lincoln, is one of several Nebraska researchers who are working to unravel the mysteries of these small organisms in support of its biofuel potential, and in 2012, his team was able to gain key insights into algal genetics.

Weeks and his team of collaborators are seeking to unlock the genetic codes that control how algae cells respond to daily changes in atmospheric carbon dioxide (CO_2) levels. CO_2 is abundant early in the day but decreases as it is used for photosynthesis. Once CO_2 levels fall, it would be expected that photosynthesis would also fall, but algae have a carbon concentrating mechanism that allows photosynthesis to continue after carbon dioxide becomes limiting in the environment. This maximizes growth over the course of a day and supports the production of lipids.

Don Weeks is the Maxcy Professor of Agriculture and Natural Resources at the University of Nebraska-Lincoln.

In order to understand what controls this competitive advantage, Weeks' graduate student, **Drew Bruggeman**, conducted experiments with the alga, Clamydomonas reinhardtii. He looked at which genes are activated or suppressed at different CO_2 concentrations based on what messenger RNAs in a cell are active at any given point in time. Messenger RNAs are molecules that take information coded in DNA and translate it to create enzymes and proteins that operate a cell. Thus, a detailed census of messenger RNAs indicates which genes have been activated and which have been deactivated. Changes in mRNA populations were then analyzed by Weeks' collaborator, **Steve Ladunga**, a computational biologist at UNL, and his postdoc, **Matt Ceshati**.

"What we found was startling," said Weeks. Approximately 38% of the cell's 15,000 genes were activated or inactivated by the absence of carbon dioxide. Weeks added, "That percentage is phenomenal... With other environmental changes you might see an eight to 10 or 12 percent change ... to see 38% was impressive."

An earlier experiment found one gene whose activation controlled the activity of a hundred other genes; further research will look for the network of regulatory genes with the hope that one day, additional genes can be identified and deliberately regulated to maximize cell growth and lipid synthesis—results with direct bearings on the feasibility of algal biofuel production.

This research is part of the collective efforts of the Nebraska Coalition for Algal Biology and Biotechnology, which was founded using a portion of the $20 million, 2010 NSF EPSCoR Award. Members of this group share a common goal of conducting basic research aimed at better understanding algae and applying this knowledge to develop algae as a renewable biofuel.

Nebraska-Puerto Rico Exchange Catalyzes Progress

Bottom: (L-R) **Nadja E Solis Marcano**, **Elizabeth Needels**, and **Myreisa Morales** in the lab at the University of Puerto Rico. *Top*: (L-R) **Elizabeth Needels** and **Dichéle Jackson** outside the El Morro National Monument in Old San Juan, Puerto Rico.

NANOMATERIALS CHEMIST by day, tourist by night—that was the life **Elizabeth Needels** led as a participant in a summer research exchange between the University of Nebraska–Lincoln (UNL) and the University of Puerto Rico (UPR). The UNL senior and four other undergraduates traveled to Puerto Rico to work in UPR research labs on collaborative projects as part of Nebraska EPSCoR's Track 2 grant. This $6 million grant, shared between the University of Nebraska and UPR, funds collaborative work between Nebraska and Puerto Rico nanoscientists working on innovations in energy efficient technologies and catalysts. It also sponsors exchanges of students and faculty to share expertise and advance research.

Needels participated in the exchange over the past two summers, contributing to the progression of a project that creates nanocatalysts for methanol and then tests their effectiveness. In Nebraska, she is a student of **Barry Cheung**, associate professor in the UNL chemistry department. During the academic year, in the chemistry department, and during the academic year she helped to synthesize platinum and cerium oxide nanoparticles, which have catalytic properties (lowering the activation energy of a chemical reaction, thereby speeding up reactions). Synthesizing the nanoparticles is the first step of a process that could yield new catalytic technologies for engines.

In Puerto Rico, Needels worked on methods to attach the platinum to the cerium oxide that she helped create in the Cheung lab in Lincoln. Once the platinum and cerium oxide were attached, she and her Puerto Rican mentor tested their catalytic capacity.

Needels says that the experience opened her eyes to the important scientific advances that can happen when two universities with complementary expertise work together to get a product that you couldn't get without the cooperation.

"It's really cool to see how intricate chemistry can be and how much we all depend on one another. The Nebraska team specializes in the synthesis of the catalyst, and the Puerto Rico team specializes in understanding how it works and getting all the different tics in electrochemistry to work. The two teams working together were really key," said Needels.

Both summers she worked for two month sessions, setting her own full-time schedule in the lab that was flexible enough that she could work on weekends when she wanted to take a weekday off to travel. And to show for her experience, Needels was invited to attend the Puerto Rico Interdisciplinary Scientific Meeting (PRISM) in March to present her work and is going to co-author a paper about the research.

"It was nice to be doing research, and when you finished for the day, you could go out and experience different things, like monuments such as El Morro. Or go dancing; one weekend we went to a really beautiful beach. It was nice to have that paired with working in a lab where you get to meet friends and meet new people," said Needels.

Cheung added, "The exchange program undoubtedly provides its participants valuable exposures to different lab cultures and networking opportunities. It also helps participants learn and appreciate different scientific perspectives."

NASA EPSCoR

TWO OF Nebraska's NASA EPSCoR research projects at the University of Nebraska–Lincoln drew to a close this year. Both projects demonstrate Nebraska's leadership in innovative areas of aerospace and space science research and the continued impact NASA EPSCoR has on the state's research infrastructure.

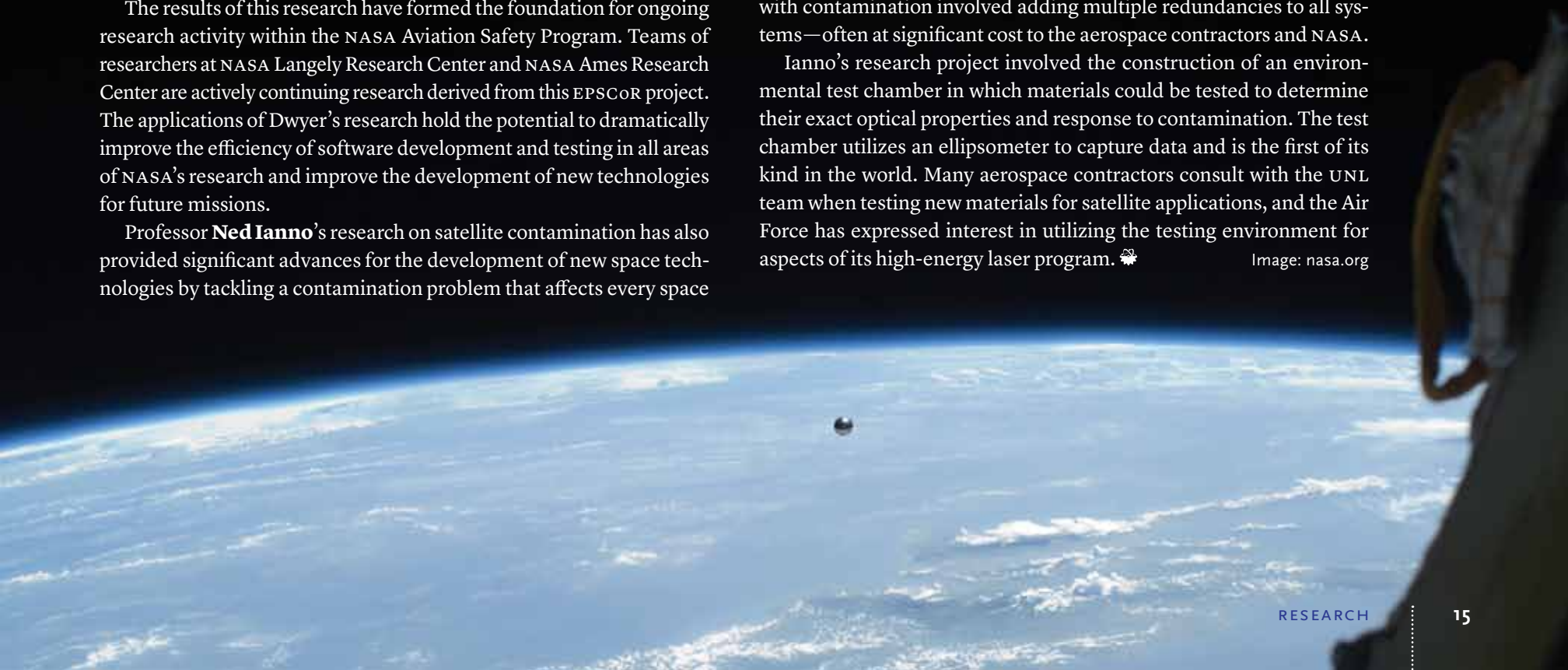
Professor **Matthew Dwyer**'s research project relating to software assurance forged new paths in differential software analysis, allowing engineers and programmers to compare the operation of two different versions of a particular program. The innovation in this research utilizes data on how software has changed in order to predict the effect those changes will have on the software's operation.

The results of this research have formed the foundation for ongoing research activity within the NASA Aviation Safety Program. Teams of researchers at NASA Langely Research Center and NASA Ames Research Center are actively continuing research derived from this EPSCoR project. The applications of Dwyer's research hold the potential to dramatically improve the efficiency of software development and testing in all areas of NASA's research and improve the development of new technologies for future missions.

Professor **Ned Ianno**'s research on satellite contamination has also provided significant advances for the development of new space technologies by tackling a contamination problem that affects every space mission. In space, sunlight fuses a thin layer of contaminants, or film, to all the exposed surfaces of spacecraft and satellites, disrupting several key instruments. Solar cells that charge the satellite batteries can be obscured by the light-absorbing film, thus shortening satellite lifespan. In addition, the temperature of the satellite is controlled by the surface properties of the satellite radiator panels. If a contaminant film deposits on these panels, the surface properties are altered and the satellite temperature may not be properly controlled, also shortening its lifetime. Perhaps the worst-case scenario is the deposition of a contaminant film on the optics of a telescope, which can potentially render the satellite incapable of fulfilling its mission. Traditional approaches to dealing with contamination involved adding multiple redundancies to all systems—often at significant cost to the aerospace contractors and NASA.

Ianno's research project involved the construction of an environmental test chamber in which materials could be tested to determine their exact optical properties and response to contamination. The test chamber utilizes an ellipsometer to capture data and is the first of its kind in the world. Many aerospace contractors consult with the UNL team when testing new materials for satellite applications, and the Air Force has expressed interest in utilizing the testing environment for aspects of its high-energy laser program.

Image: nasa.org



Nebraska EPSCoR Economic Development Programs Adapted by the State

ECONOMIC DEVELOPMENT is expanded and sustained by a complex system of inputs, one of which is a well-prepared pipeline of employees, and another is a bridge between academic and private industry innovations. For twelve years, Nebraska EPSCoR has promoted economic development in the state through two key programs: the Nebraska Engineering, Science and Technology Internship Program (NESTIP) and the University-Industry Research & Development Partnership Award. While these programs continue, since 2011 the state of Nebraska has funded its own programs modeled after these public-private initiatives.

We are encouraged by the state's initiatives to link industry and academia.

NESTIP provides up to $5,000 in a 50% cost-share for businesses that hire undergraduate and graduate students for project-based paid internships in science, technology, engineering and mathematics (STEM). Nebraska EPSCoR has a limited number of internships that can be funded each year, however, students and businesses interested in these subsidized internships can also turn to the state-run and funded InternNE program.

InternNE was authorized by legislation in the spring of 2011 as part of Governor Heineman's Talent & Innovation Initiative. The program connects students and businesses across the State in order to position Nebraska as the ideal place to create jobs, grow a business, and obtain an education. Like NESTIP, Intern Nebraska provides a cost-share structure (40–50% of a paid internship up to $5,000). The InternNE.com portal was designed to provide a centralized location for job seekers to find quality, paid internships. By December of 2012, 361 internships had been filled through this program and $2.46 million had been awarded or disbursed.

A second program pioneered by Nebraska EPSCoR has been adopted by the state. Nebraska EPSCoR's University-Industry R&D Partnership Award offers early-stage funding of up to $25,000 for promising collaborative research and development projects between university faculty and Nebraska businesses. The state's Academic R&D Program, a part of the Business Innovation Act (LB 387) of 2011, was similarly structured. Competitive grants provide businesses $100,000 for the first phase and a potential for $400,000 for a second phase collaboration with Nebraska academics to support product design, development and testing. This affords the possibility that a recipient could receive initial support through Nebraska EPSCoR's program and then apply to the state for continued funding as the partnership project matures. Nebraska EPSCoR awarded one R&D partnership award in 2012, and the state awarded five grants totaling $498,450.

Nebraska EPSCoR is encouraged by the state's initiatives to link industry and academia.

Young Nebraska Scientists Use Their Summers to Discover

THE YOUNG Nebraska Scientists summer camps offer middle and high school students unique and fun ways of learning and exploring science. The camps take place on Nebraska's college and university campuses. Many YNS experiences are linked to EPSCoR-funded research projects, allowing participants to interact with researchers and learn about their approaches to solving key societal challenges. In 2012, participants learned to apply computer programming through the lens of DNA transcription and translation, they tested different growth environments to maximize lipid production for biofuels in algae, and they discovered the superhero properties of nanoscience. Students are exposed to a diverse range of experiences designed to engage their interest in science beyond the duration of the camp and into the rest of their lives.

Students at the Young Nebraska Scientists' *Going Green! Algae for Biofuels* camp look at algae under a microscope.

Campers at the *Going Green! Algae for Biofuels* camp went to Spring Creek Prairie to learn how to release and light methane trapped in the pond mud.

"Going Green! Algae for Biofuels" camps were hosted by Doane College, in Crete. The camp included activities in basic algal biology and biofuels, field collection and identification, and critical thinking skills, developed by **Brad Elder**, associate professor of biology at Doane College, and his team of undergraduate students. The camps included a field trip to a local pond where participants learned how to safely release and ignite methane gas that's produced and trapped in the subsurface mud.

A second year of nanoscience camps were held in Omaha at Creighton University under the guidance of **Stephen Gross**, associate professor of organic chemistry at Creighton University. Camp participants visited the Nanoparticle Synthesis Laboratory and the Scanning Electron Microscope (SEM), applied their knowledge to design projects based on nanoscale concepts, and even learned about nanoscience in nature during a day-long field trip to the Henry Doorly Zoo.

And for the second time, YNS offered high school students a week of training in the computer programming language Python, led by **Ashu Guru** of the University of Nebraska-Lincoln's Holland Computing Center. In addition to coding instruction, the camp emphasized the many fields that are impacted by computer programming. Participants toured the Department of Computer Science and Engineering, the Schorr Computing Center, and received an orientation on bioinformatics and the new Computational Biology and Bioinformatics programs at UNL.

Preliminary results indicate that YNS camps have had a positive and lasting impact.

Preliminary Long-term Impact Results

With five years of summer camps completed, Nebraska EPSCoR teamed up with the Nebraska Bureau of Sociological Research (BOSR) to survey past campers on the impact that Young Nebraska Scientist Camps may have had on its participants. Preliminary results have been released while BOSR completes its final analysis, and they indicate that YNS camps have had a positive and lasting impact on a majority of participants' understanding, perception, and career aspirations regarding science, technology, engineering, and mathematics (STEM).

"We are excited to see the evidence of the collective impact that the Young Nebraska Scientist program has had on its campers. We are learning more and more that informal science learning that takes place outside the school classroom is important for students, as well as the general public. Over time, an accumulation of intriguing STEM experiences can increase the number of students who choose STEM studies and careers in the future, as well as increase the scientific literacy of our society, " says **Sarah Zulkoski**, outreach coordinator of the Young Nebraska Scientist program at Nebraska EPSCoR.

Supporting STEM at Nebraska Tribal Colleges

NEBRASKA EPSCoR has a longstanding commitment to the state's two tribal colleges, the Little Priest Tribal College and the Nebraska Indian Community College. Both colleges offer two-year associate degrees and together serve just over 300 students, most of whom have tribal affiliations. Two EPSCoR grants have enabled Nebraska EPSCoR to co-fund science instructors and significantly upgrade the cyberinfrastructure bandwidth to 100 megabits at each college.

Nebraska Indian Community College

The Omaha and the Santee Dakota tribes established the Nebraska Indian Community College (NICC) in 1973, and it currently serves its students from three campuses in northeast Nebraska: Macy, Santee, and South Sioux City. The college offers associate degrees, including one in General Science Studies that focuses on natural resource management with courses such as chemistry, math, geology, wildlife ecology, and soil and water management.

Improvements to the college's bandwidth significantly upgraded courses taught by videoconferencing. According to **Justin Kocian**, director of Title III for NICC, "The increase in bandwidth has allowed us to teach 90% of our courses through video teleconferencing, and we were able to upgrade the systems to high definition, reducing delays and improving student satisfaction." The NICC has also established KZYK 88.9 FM in the summer of 2012, a radio station that broadcasts Dakota language programs, music, and other cultural and educational content. The radio station benefits from the increased bandwidth provided ▸

The increased bandwidth has enabled the Nebraska Indian Community College to teach 90% of its courses via video teleconferencing to its three campuses.

by EPSCoR and allows for rebroadcasting of national news to a wider audience.

In addition, two science instructors co-funded by Nebraska EPSCoR are pursuing projects to support ecological research, a healthy food program with food gardens, and use of geoscience technology in the classes. The head of the math/science division at NICC, **Henry Miller**, writes, "Thank you, Nebraska EPSCoR, for your financial help to make these projects a reality for our respective communities."

Little Priest Tribal College

Little Priest Tribal College (LPTC) is in Winnebago, a small town near the Missouri River in the northeast corner of the state. The college was chartered by the Winnebago Tribe of Nebraska in 1996 to provide associate degrees that could be transferred to four-year institutions, workforce development training, and language and culture classes. The college offers two STEM degrees: Indigenous Science, with classes in biology, environmental science, and chemistry; and Computer Information Systems. Nebraska EPSCoR co-funded one science instructor at the school, freeing up resources for other college priorities.

Prior to the involvement of Nebraska EPSCoR, LPTC's connection to the internet was through a slow T1 line with a maximum transfer ability of 1.5 megabits per second (Mbps). The installation of new fiber optic cables with higher bandwidth has expanded access to online courses at other colleges and universities, expanding institutional collaborations across the state and beyond. According to **Brandon Stout**, director of Information Technology at LPTC, this is a "night and day difference!"

Another critical outcome was the ability of LPTC to obtain a radio license and begin broadcasting. The increased bandwidth allowed the college to stream recordings to the radio tower in Homer, Nebraska. This long-dreamed project was finally realized in the fall, and the station is now broadcasting cultural and educational programming, as well as music, over the internet and through the air.

2012 Federal EPSCoR Awards

NSF EPSCoR Co-Funding

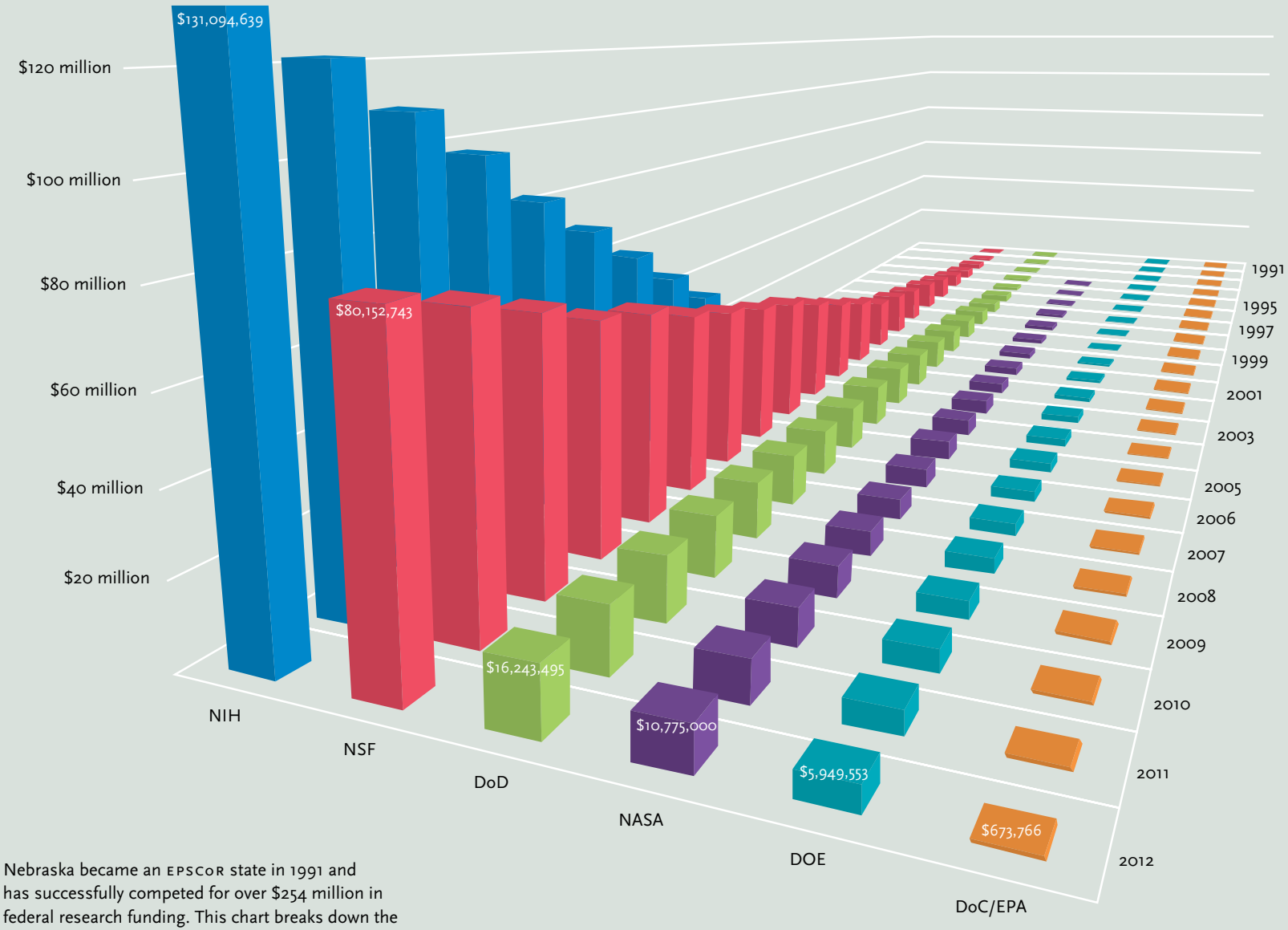
CO-FUNDING IS a mechanism to increase the number of worthy projects that are funded in EPSCoR states by providing an EPSCoR funding supplement to National Science Foundation directorates. In 2012, EPSCoR co-funding contributed $542,455 to the following awards:

GARDE: Developing a World-Class Rehabilitation Engineering Workforce in America's Heartland. PI: **Carl Nelson**, Co-PIs: **Linxia Gu**, **Judith Burnfield**, University of Nebraska–Lincoln. $449,775

CAREER: Interface Engineered Multiferroics and Nanoscale Phase Modulation in Complex Oxide Heterostructures; PI: **Xia Hong**, University of Nebraska–Lincoln. $600,000

RET in Engineering and Computer Science Site on Infusing Mobile Platform Applied Research into Teaching (IMPART); PI: **Qiuming Zhu**; Co-PI: **Harvey Siy**, University of Nebraska at Omaha. $449,775

Total Federal EPSCoR Funding in Nebraska



Nebraska became an EPSCoR state in 1991 and has successfully competed for over $254 million in federal research funding. This chart breaks down the funding by agency and shows the cumulative growth of funding over time.

EPSCoR
Nebraska EPSCoR
University of Nebraska
W192 Nebraska Hall
P.O. Box 880557
Lincoln NE 68588-0557

State EPSCoR Committee Members

IDeA EPSCoR NEBRASKA

Experimental Program to Stimulate Competitive Research
Institutional Development Award Program

https://epscor.nebraska.edu
Follow us on Twitter @NebraskaEPSCoR