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EPSCoR/IDeA

Experimental Program to Stimulate Competitive Research
Institutional Development Award Program

BUILDING ON THE PAST, PREPARING FOR THE FUTURE: Innovative Science across America

EPSCoR/IDeA Foundation
Washington, DC
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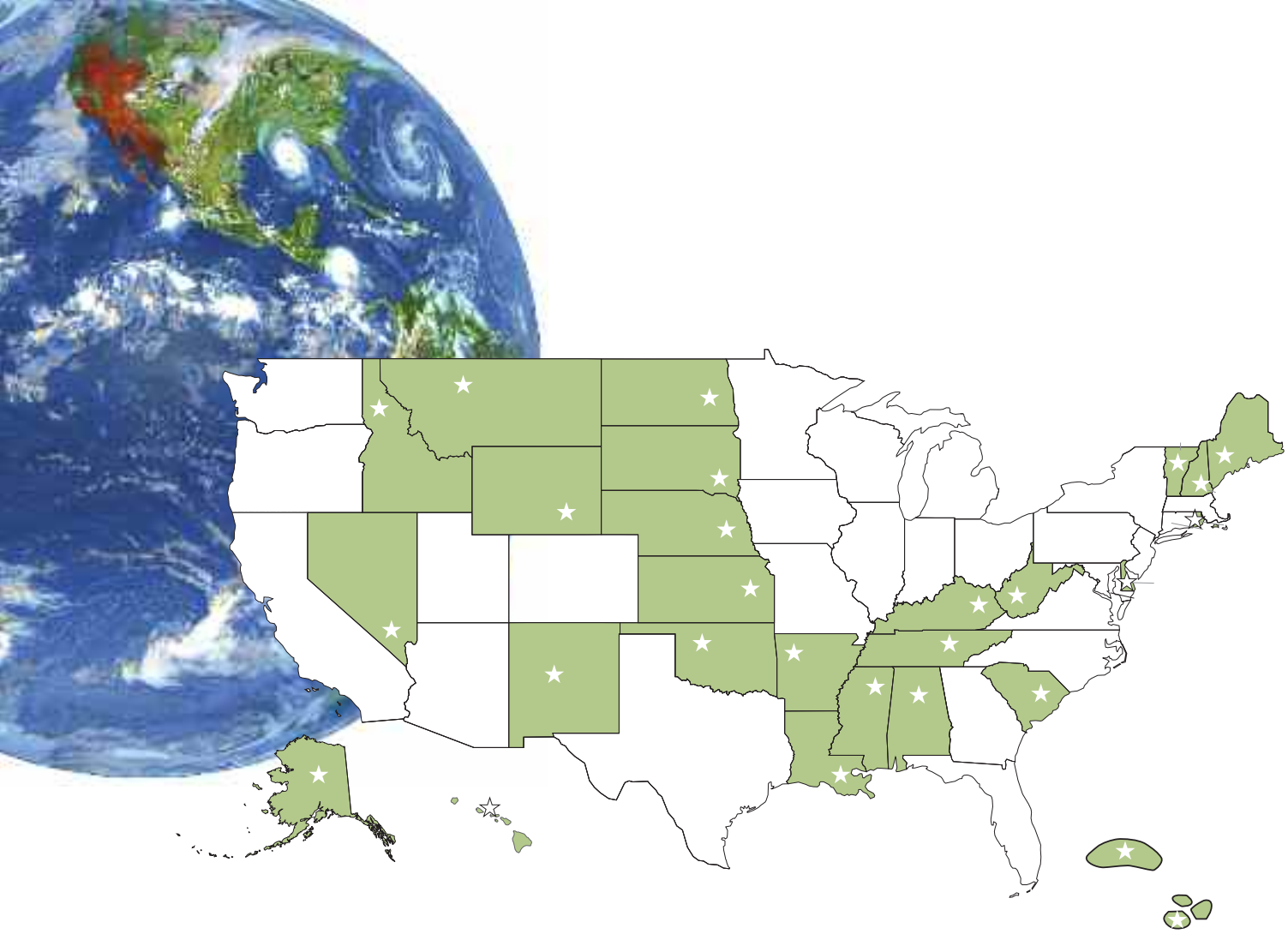

Acknowledgements: Without the work of the **EPSCoR/IDeA** jurisdictions, this report would not be possible. Over the last decade, the 25 states and two jurisdictions that participate in the federal-wide EPSCoR/IDeA program have made major advances in their research infrastructure and competitiveness. Each of the project directors and administrators, the research faculty, the institutional and state leadership, as well as State Committees, are to be applauded for their efforts.

The EPSCoR/IDeA Foundation recognizes, appreciates, and supports the federal agencies with EPSCoR, EPSCoR-like, and IDeA programs, and their efforts to build the research infrastructure across the nation. EPSCoR/IDeA is a model federal-state partnership, and we appreciate the creativity and ingenuity of the agencies and program managers in working with the participating jurisdictions to design and implement effective programs.

We are grateful for the efforts of the principal authors of this report, *Mr. Gerard Glaser* and *Mr. James Hoehn*, both Senior Associates, as well as *Ms. Bonnie Calhoun*, Project Associate.

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FOREWORD

The Experimental Program to Stimulate Competitive Research (EPSCoR) was established by the National Science Foundation (NSF) in 1979 in response to Congress's desire to ensure that the benefits of NSF-funded research accrued to all states and regions of our nation. Over time, EPSCoR became a federal-wide effort and now exists in seven agencies that support academic research activities: the Departments of Agriculture, Defense and Energy, the Environmental Protection Agency, the National Aeronautics and Space Administration, NSF, and the National Institutes of Health, where it is named the Institutional Development Award (IDeA) program.

The federal-wide EPSCoR/IDeA program has dramatically transformed and improved the scientific research enterprise and environment in universities and colleges in the 27 participating jurisdictions. EPSCoR/IDeA researchers are using their expertise to solve fundamental research challenges, as well as to carry out mission-oriented research in the areas of energy, health, defense, homeland security, the environment, aeronautics and space, and agriculture. Their work is helping federal agencies to carry out research in important areas related to our citizenry's health and well-being.

This report documents some examples of the community's efforts and achievements. These examples reflect the accomplishments of those in the EPSCoR/IDeA community and help illuminate the science-driven aspects of our work. We hope these examples contribute to a broader understanding that all regions of the nation contribute in important ways to the nation's advances in science and technology.

This report is divided into two primary sections; the first provides a snapshot of each participating jurisdiction's EPSCoR/IDeA program; the second provides illustrative examples of research accomplishments and achievements, and showcases the wide variety of strategies being used to meet EPSCoR/IDeA goals.

The EPSCoR/IDeA Foundation, established in 1996, promotes the importance of a vibrant, national science enterprise, helps to improve the research infrastructure of states that historically received lesser amounts of funding, and brings visibility to the talent and capability these states have to offer.

Paul Hill, Ph.D.
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Introduction

The need to sustain and accelerate the nation's preeminence in science and technology (S&T) is imperative as we face challenges unique in our history. For more than a century, the United States has successfully maintained its prominent position despite numerous challenges. America marshaled its S&T resources to help the nation prevail in times of both war and peace, developing the tools to bring victory in two world wars, implementing the world's "Green Revolution," winning the Space Race, and raising standards in medical care. These and other achievements were, in large part, due to the strength and vitality of our country's higher education system and its research components. Together, they have provided the scientific expertise and facilities to address research challenges as well as the mechanism to educate multiple generations of S&T workers, entrepreneurs, and business leaders.

Currently our nation's leadership in science and technology is being challenged, perhaps as never before by: (1) the sheer number of scientists and engineers being educated throughout the world; (2) rapid advances in the quality of the scientific and technological education and research facilities globally; (3) the globalization of science and technology enabled by the internet and experience with the human genome project and other large databases; (4) the growing number of international collaborations, shared facilities, and other S&T interactions; (5) the lack of interest among U.S. students in pursuing degrees in science, technology, engineering, and mathematics; (6) a complacency that anticipates America's preeminence will continue; and (7) a failure in the U.S. to develop and utilize the full scientific and technological resources that exist throughout the states. This challenge to America's leading role in the world's S&T enterprise is ultimately a challenge to our nation's quality of life, our economic vitality, and our national security. How we live tomorrow will be determined by the S&T decisions and investments that we make today.

There is little doubt that the next few years are crucial. According to the National Science Board Report, *2020 Vision*, "History suggests that a nation that relinquishes the torch of science puts its future prosperity at risk and jeopardizes its place in the history of civilization."

Clearly, leaving half the states behind is not an acceptable national R&D policy. How can the United States develop a truly national S&T enterprise and make use of all its resources, regardless of where they may be geographically located? How can we ensure that the torch of science shines throughout the nation?

The goal of the federal-wide EPSCoR/IDeA program is aligned with the original NSF EPSCoR congressionally-mandated mission to "strengthen science and engineering research potential and education at

all levels throughout the United States; and avoid undue concentration of such research and education, respectively." Today, the 27 EPSCoR/IDeA jurisdictions that participate in the federal-wide program account for 20 percent of the U.S. population, 25 percent of the research/doctoral institutions, and 18 percent of the employed scientists and engineers. Yet they are not full partners in the S&T enterprise.

While dramatic advances in research infrastructure and competitiveness have been made by these states over the last decade, they continue to garner less than their current competitive level warrants – a pattern seen throughout the federal R&D agencies. At present, EPSCoR/IDeA states receive less than 10 percent of federal R&D funding. This situation argues for a continuing vibrant national EPSCoR/IDeA effort. Without this, the nation will fail to utilize the growing talent and resources of half the U.S. states – states and their institutions that increasingly are winning major NSF and other agency awards, expanding their research capacity, producing Goldwater and Truman scholars, and moving into the top Carnegie and other rankings.

Today, the EPSCoR/IDeA states and their research institutions have developed unique S&T-related abilities and expertise that are contributing to national issues. Some are among the top net energy exporting states, others are at the forefront of knowledge of coastal and ocean issues and other fundamental research challenges, while still others are undertaking vital work in health, homeland security and national defense, and other areas.

The first EPSCoR program was initiated by the National Science Foundation in 1979, with planning grants to seven states. Today, EPSCoR, IDeA or EPSCoR-like programs are found in six additional agencies: the National Institutes of Health, the Departments of Defense, Energy and Agriculture, the National Aeronautics and Space Administration, and the Environmental Protection Agency. The NIH's Institutional Development Award (IDeA) program is the largest of the EPSCoR/IDeA federal-wide programs. (See Summary of EPSCoR/IDeA Programs by Agency.)

Funding levels for program and agency participation became significant only in the mid-1990s, and true infrastructure building (as opposed to individual investigation) is a recent focus. Over the past few years, the structure of EPSCoR/IDeA has stabilized and progress has become evident.

Summary of EPSCoR/IDeA Programs, by Agency

Agency	Date Enacted (FY)	FY 08 Enacted Budget ($ in millions)	Types of Support/Award Mechanisms
NSF / EPSCoR	1979	$115.0	◗ Research Infrastructure Improvement Awards ◗ Co-Funding
DoD / DEPSCoR	1991	$17.0	◗ Basic and Applied Research Grants ◗ Graduate Traineeships ◗ Research Instrumentation
EPA / EPA EPSCoR	1991		◗ Co-Funding
DoE / DoE EPSCoR	1991	$15.0	◗ Laboratory-State Partnership Awards ◗ Implementation Grants
USDA / USDA EPSCoR	1991	$19.2	◗ Research Career Enhancement Awards ◗ Equipment Grants ◗ Seed Grants ◗ Strengthening Standard Research Project Awards
NASA / NASA EPSCoR	1993	$15.5	◗ Research Implementation Awards ◗ Research Infrastructure Development Awards
NIH / NIH IDeA	1993	$220.5	◗ Centers for Biomedical Research Excellence (COBRE) ◗ IDeA Networks of Biomedical Research Excellence (INBRE) ◗ Co-Funding

EPSCoR and IDeA funding of basic research infrastructure has enabled these states to develop scientific expertise in fundamental science and engineering, health, energy, environment and agriculture, aeronautics and space, defense, and homeland security, among others. Already researchers who were originally supported by EPSCoR/IDeA are making important contributions in areas that are related to the America COMPETES Act.

In addition to its primary goal of strengthening research infrastructure in the states, the EPSCoR/IDeA programs are:

- involving more women and other underrepresented groups in S&T;
- integrating education, research and training at the undergraduate and graduate level across departments and with the private sector;
- stimulating and supporting partnerships within and across states;
- facilitating commercialization of research results and business involvement and development; and,
- increasing state awareness and support for strong R&D and education.

Combined with a stronger research infrastructure and competitiveness, these efforts are also paying dividends in the form of: (1) a more qualified, diverse workforce with a greater percentage entering S&T careers, and getting technical jobs or starting high-tech companies; (2) increased institutional and state allocations for research; and (3) increased public acceptance of the importance of a stronger R&D base for a strong economy.

This document highlights the state programs and some of the exciting science and educational activities that are ongoing in the states and positioning them to help address a variety of contemporary national research and education challenges.

EPSCoR/IDeA State Summaries

ALABAMA

The lowly jellyfish may provide the key to helping soldiers and others recover from wounds, according to researchers in Alabama. Jellyfish are very delicate marine animals. They face mortal danger from any wound to their epithelial "skin," so they have developed an extremely rapid, scar-free, repair mechanism similar to that seen when mammalian fetus cells heal.

Scientists in Alabama are conducting research designed to better understand how this process works. They are producing time-lapse images of live jellyfish cells as they heal and comparing them with much more detailed images taken with an electron microscope. The goal is to identify the phenomena that are responsible for wound repair. They hope to pinpoint the molecular-level mechanisms that underlie ultra-rapid scar-free healing. Ultimately, this work may reveal basic cellular processes associated with wound healing in mammals, including man.

In other work, notable for its support from multiple agencies and industrial partners, Alabama researchers are developing advanced laser technologies that have broad potential for applications in remote sensing. Through the development of "tunable" lasers, these investigators are paving the way for devices vital to remote sensing of chemical, biological, or explosive agents; environmental spills; and numerous health-related applications.

ALASKA

An Alaska researcher studying frozen lakes in Siberia and Alaska has pinpointed a phenomenon that could prove a significant factor in understanding global climate change. The work has revealed that methane bubbling out of Arctic lakes was the likely source of a huge spike in atmospheric methane at the end of the last Ice Age. Methane is a greenhouse gas believed to contribute to climate change, and this research suggests that the current warming trend could lead to another mass release of methane, which would then exacerbate the warming. Scientists estimate that as the permafrost thaws, these lakes will release as much as 10 times the amount of methane that is currently in the atmosphere.

Ice cores from Greenland and Antarctica have shown that during the early Holocene Period -- about 14,000 to 11,500 years ago -- the levels of methane in the atmosphere rose significantly. Previous hypotheses suggested that the increase came from gas hydrates or wetlands, but Alaska's new findings indicate that a third and major source of this gas is likely to be the methane bubbling from "thermokarst lakes," lakes that are formed when permafrost thaws rapidly. Methane bubbling from Arctic lakes could have been responsible for up to 87 percent of the Holocene methane spike. The current studies have been focused on areas of Siberia and Alaska that, during the last Ice Age, were dry grasslands atop ice-rich permafrost soil. As the climate warmed, that permafrost thawed and formed the lakes.

Scientists in Alaska are also working in biomedical areas where their studies could contribute to a better understanding of the spread of viral diseases. They are leading an international collaboration to learn more about the avian influenza, called H5N1, that has the potential to spread to humans and cause widespread illness. This research could lead to new knowledge of the biology of the virus that would be helpful in predicting its emergence and containing its spread.

ARKANSAS

Biomedical research holds great promise in Arkansas where the emphasis is on multidisciplinary work in cellular signaling, growth, and differentiation. The program has three major core activities. The bioinformatics core activities are designed to provide a statewide research and educational resource to give undergraduate faculty and students access to the computational tools needed for multidisciplinary biomedical research. The science research core component consists of genomics, proteomics and digital microscopy activities that provide investigators access to sophisticated instrumentation and workshops in experimental design and use. The third core, mentoring and outreach initiatives, are fully integrated with the biomedical science initiatives.

Among the challenges faced by biomedical researchers is the need to transfer discoveries in basic science to clinical settings, and then to application in medical practice. Only through this transference can tangible benefits to public health be achieved. Arkansas scientists have designed a Center for Translational Neuroscience to facilitate the migration of new discoveries from the laboratory to medical practice. Additionally, these translational concepts are emphasized in efforts to mentor scientists who might chose careers in translational research.

A new robotics program has also been inaugurated as one component in an effort to improve Science, Technology, Engineering, and Mathematics (STEM) education in Arkansas. This project is designed to inspire students to pursue careers in STEM disciplines through participation in a sports-like robotic competition. This activity has engaged 22 schools across the state.

Computational science plays a major research role in the work of Arkansas investigators, as well, and their work is being facilitated by the arrival of a new supercomputer. Solidifying its role as a national leader in high-performance computing, the University of Arkansas is assembling a machine that will be among the fastest supercomputers in all U.S. academic institutions.

The computer will enable new and ongoing projects in computer science, physics, chemistry and other areas. Perhaps more importantly, by connecting to networks and other high-performance computers, the supercomputer will significantly augment the state's computing infrastructure and facilitate collaboration among researchers at all institutions within the University of Arkansas System. The new machine will operate at a speed of six teraflops, approximately four times faster than Red Diamond, the university's first supercomputer and currently the only supercomputer in Arkansas.

State Summaries

DELAWARE

Delaware plant researchers have discovered how one of the most invasive plants in the U.S. – a non-native common reed called *Phragmites australis* – kills off neighboring plants. A toxin secreted by the plant's roots causes structural proteins in adjacent plants to disintegrate. Within 10 minutes of exposure to the toxin, the marsh plant under siege starts to deteriorate, and within 20 minutes, the structural material in its roots is completely gone.

The common reed is found throughout the continental United States, and, according to the scientist who made this discovery, *"Phragmites* is taking over the marsh world . . . It's a horticultural disaster." Once it kills off its neighbors, it forms dense colonies in delicate marshlands. Unlike other plants that release harmful chemicals to prevent others from growing too close, the reed uses this strategy to conquer them and invade new territory. Information revealed by this research has implications for addressing potential mechanisms for controlling growth of this plant species, and it may shed light on the chemical processes that take place among all species where part of their life cycle includes "allelopathy," the phenomenon of plants inhibiting the growth of one another.

HAWAII

The Hawaiian Islands serve as a natural laboratory for investigating ecological and genetic factors that govern ecosystem evolution and environmental adaptation to change. Research priorities for Hawaiian scientists include advanced environmental sensor technology, evolutionary genetics, and ecosystems research. To complement these efforts, scientists also support educational outreach, recruitment, and retention activities in science and engineering that focus on Hawaii's diverse population. Additional efforts directed toward development of a more robust cyberinfrastructure are also underway to support these research initiatives.

As a follow-on to earlier work conducted for NASA in telemedicine, Hawaii has pioneered the use of wireless sensor technology to provide integrated global monitoring systems. These systems are designed to automatically interoperate with data from many other sources and provide real-time advanced visualization.

Developed through a private-sector spin-off company, Intelesense Technologies, these monitoring systems are used to help researchers better understand the interaction between environments and people. They are being used to monitor and protect natural resources, predict and facilitate adaptation to environmental change, and provide for sustainable development. In addition, they help reduce the cost and impact of natural disasters by providing better information for guiding response strategies.

IDAHO

Idaho's research in nanotechnology is focusing on new ways to target and destroy human cancer cells. Using innovative microscopic "nanowires," scientists have shown they can deliver drugs and other chemicals to the nucleus of a particular cell without harming nearby healthy ones.

Nanoscience and cell biology are among several areas of research excellence made possible through Idaho's participation in the EPSCoR/IDeA program. Researchers have also created new ways to follow the course and location of bacterial infections, without harming the animals used in the test. Meanwhile, the state's leadership role in aquaculture research is also being recognized. The University of Idaho is now the nation's top school for scholarly publications in the field of fish diseases, and worldwide, it is ranked No. 7. On another front, Idaho researchers will be among the first to permanently deploy sensors in a river system – the Portneuf River Basin – which will comprehensively monitor and report flow, temperature, oxygen levels, and other critical data for measuring ecosystem metabolism. This monitoring system will provide managers and stakeholders with essential data for making decisions about water-quality management in the Basin.

KANSAS

Hydrogen chemical bonds – the interactions between hydrogen and an adjacent atom – can function as nature's glue by molding the shape of molecules. Such bonds, for example, are responsible for holding molecules of water together in ice crystals. Kansas scientists have discovered a unique form of hydrogen bonding that may shed light on new and complex processes such as "protein folding" – the process whereby a protein molecule assumes its intricate three-dimensional shape. Understanding protein folding is a critical step in deciphering the genetic code. This work contributes to knowledge of the factors involved in how proteins form their complicated but consistent folding patterns.

On the education front, an interactive, multimedia education project is helping young students understand complex scientific concepts. The program has created a developmentally-appropriate system for introducing kids to the concept of quarks – one of the basic building blocks of every atom in the universe. The effort is based on research aimed at a better understanding of how young people are introduced to and grasp the scientific world of the unseen and abstract. It also focuses on demystifying subatomic physics and changing the perception that science is difficult and inaccessible.

State Summaries

KENTUCKY

Mathematical algorithms developed by one Kentucky scientist have led to an improved technology for detecting landmines. According to one partner in this effort, there are some 80 million landmines buried around the world, and, thus, the algorithm produced by this project can make great strides in saving lives and lessening the potential for destruction by these devices. Their system works in conjunction with Ground Penetrating Radar and involves close collaboration with the U.S. Army's night-vision laboratory and a number of private sector corporations.

Kentucky researchers are also pursuing work in visual imaging, biometric authentication, and the development of pressure sensors that can help prevent glaucoma. This research is a good example of how discovery has led to the transfer of knowledge into economic-growth opportunities for the commonwealth. One spin-off company is developing digital imaging capabilities that will merge functionality, accessibility, and affordability to create large, high-resolution visual displays. In another area, research at a nanotechnology research center has enabled the formation of several technology start-up companies. Kentucky's Cabinet for Economic Development has provided some $6 million to support grantee proposals to federal agencies, which illustrates the commonwealth's commitment to transformative science and technology as a strategy for economic growth.

LOUISIANA

One of the top priorities for Louisiana scientists and engineers is the development of new cyber tools for high-performance computing, advanced networking, and data management capabilities. Their work involves the careful integration of cyberinfrastructure tools with "science-drivers," and with education and outreach activities. For example, science drives the researchers' work in the simulation, design, and manufacturing of miniaturized antibody-based sensors; this, in turn, is supported by the cyber tools that are needed for the theory and methodology of the project.

On a parallel track, faculty development and outreach is addressed through integrated programs to stimulate the long-term research competitiveness of faculty members, and to engage Louisiana's large population of underrepresented minorities in science and technology careers. These education programs train, recruit, and mentor undergraduate and graduate students, and postdoctoral researchers.

This work has led to a micro-nano consortium for the development of commercially viable micro/nanoscale systems with applications in biology, chemistry, and other fields. Additionally, further research is being conducted to develop new chemistries and materials — on the molecular, nanometer and micron scale — that can be integrated into high-performance devices.

At the same time, Louisiana has reaffirmed its commitment to building a high-speed optical network, the Louisiana Optical Network Initiative (LONI), which will serve as a gateway to the world via the National LambdaRail (NLR) — a high-speed national computer network that runs over fiber-optic lines. The state will provide one-half of the computational cycles of Queen Bee, its 50 teraflop supercomputer, a machine that is ranked the fourth most powerful of its kind at U.S. universities.

Louisiana researchers are also engaged in projects aimed at increasing U.S. oil and gas production through projects on wireless and sensor network systems, geoscience data integration, grid computing and storage, and application-monitoring software. Other work under the DEPSCoR program will develop research and educational capabilities in coastal engineering and science, while supporting the Navy's research goals in coastal geosciences and physical oceanography.

Louisiana's work for NASA involves on high-altitude balloon and space experiments; gravity-wave studies at the Laser Interferometer Gravitational Wave Observatory (LIGO) facility; and the Pierre Auger Observatory (AUGER) project, which studies the highest energy particles in the galaxy.

In health research, Louisiana is engaged in a diverse portfolio of activities involving cardiovascular biology, cancer genetics, neuroscience, and obesity and diabetes. Scientists are also conducting programs in the prevention of oral diseases, infectious diseases, and hypertension, as well as projects involving renal biology, molecular and tumor virology, and translational research that will move laboratory findings into clinical settings.

State Summaries

MAINE

Scientists in Maine have taken a leadership position with their research on forest products. One key initiative is aimed at producing diverse "bioproducts" at mills traditionally dedicated to such products as pulp or paper. These bioproducts include fuels, chemicals, and polymers, and hold promise for great improvement in the productivity and economic competitiveness of this critical industry. The discoveries will improve conservation and the efficient use of Maine's natural resources.

In a recent breakthrough, scientists demonstrated a process where wood extracts could be fermented into ethanol, despite high concentrations of chemical inhibitors that are normally present and too time-consuming and costly to remove. Researchers have learned that the bacteria necessary to ferment wood can remain viable, and that they may be able to efficiently extract inhibitors like acetic acid (which is essentially vinegar) and offer it as another bioproduct for sale.

Maine's commitment to the integration of research initiatives with economic growth opportunities is seen in the success of several entities, including the Forest Bioproducts Research Initiative, the Institute for Molecular Biophysics, and the Advanced Engineered Wood Composites Center.

In another area, Maine's biomedical researchers have made great strides in work on vascular biology and tumor stem cells. The work examines "cell signaling" related to vascular inflammation and the role of blood vessels in tumor growth, metastasis, and bone inflammation. A clearer understanding of how blood vessels support tumor growth could lead to new therapeutic strategies for controlling many forms of cancer.

MISSISSIPPI

Mississippi researchers are collaborating on efforts to develop a mathematical, "open-source" computer model for studying human physiology. The model describes human physiology using many different types of information. These include data about "whole-body properties" (weight, nutrient levels, and blood characteristics), and data about organs, multi-organ systems, and cellular, molecular, and chemical functions. The model contains over 3,000 such variables and enables users to calculate time-dependent solutions and to alter parameters in order to investigate new hypotheses relevant to laboratory and clinical research.

This new tool has led to several studies already. One is aimed at understanding the role of the nervous system in the control of blood pressure; another involves efforts to simulate biological responses to long-term weightlessness, such as muscle atrophy; and a third examines the role of the liver in creating and maintaining insulin resistance.

Other research by Mississippi scientists in bioinformatics and computational biology has helped transform the biological sciences. One project studies Universal Stress Proteins, the molecules that play a significant role in plant species that can adapt to environmental stresses such as drought, salinity, and oxygen deprivation. The genes that control these proteins have not been extensively characterized, and this work is intended to fill this gap in our knowledge.

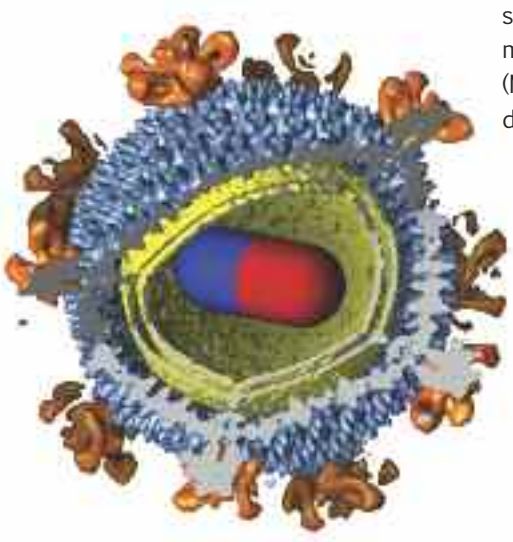
These new techniques have also allowed Mississippi scientists to map three newly sequenced genomes of bacteria that commonly cause respiratory disease in cattle, and to conduct promising new work on improving current "annotations" of biofuel microorganisms. These specific projects – conducted within the context of biomass technology; plant breeding and genomic research; and crops and aquaculture research – are contributing to substantial economic benefits for farmers and others involved in biotechnology in Mississippi.

MONTANA

Montana scientists have discovered a valuable use for new life forms discovered in the thermal hot pools of Yellowstone National Park. These life forms can grow in extreme environments akin to boiling battery acid. Structures called "protein cages," derived from these life forms, act as microscopic containers carrying drugs to specific cells and tissues. In effect, they can become "smart" vehicles for delivering powerful therapeutic agents, such as cancer drugs, to specific cells, while avoiding the others. Thus, doctors may be able to avoid flooding the body with chemotherapy drugs that cause severe side effects. Tests of this process are underway.

Complementary research, also with protein cages, has led to new catalytic "nanoparticles" that efficiently produce hydrogen. This process has significant potential as an economical energy alternative.

Could microorganisms with an appetite for radioactive waste clean up some of the nation's nuclear dumps? That's another question scientists at Montana State University and the Idaho National Laboratory hope to answer. The Department of Energy (DOE) knows of more than 10,000 individual waste sites. Heavy metals, such as chromium, and radionuclides, such as uranium, have a high potential to contaminate clean groundwater near the disposal sites. Containment is the first step toward protecting human health and the environment. Unfortunately, there are now few ways to slow or stop this dispersion, and they involve pumping the contaminants to the surface or the introduction of toxic chemical external components. Montana State University and DOE scientists and engineers hope microorganisms will provide a better solution. Harnessing microbes naturally promises effective and less invasive bioremediation.



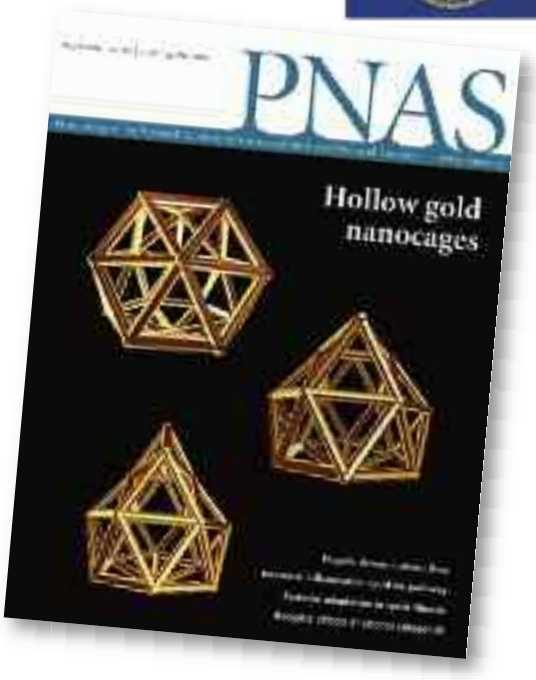
In concert with these critical research activities, Montana supports science enrichment programs for Native American students, guiding and supporting them from high school through graduate school in science, technology, engineering and mathematics (STEM) disciplines. The first step is the Montana Apprenticeship Program (MAP), which provides Native American high school students an opportunity to conduct scientific research at Montana State University while living on campus and participating in preparatory math and science courses. Over 75 percent of those in the apprenticeship program go on to college, with over half attending Montana State University. Another program, BRIDGES, focuses on tribal college students who want to transfer to a four-year university to complete their bachelor's degree in a science field. Through BRIDGES, 45 tribal college students have participated in the summer program that provides students a research experience, a math class, study skills coursework, and an opportunity to participate in a national research conference. Over half of the tribal college students who have participated in BRIDGES go on to four-year schools.

State Summaries

NEBRASKA

Scientists in Nebraska are engaged in a broad array of research and education activities, ranging from projects involving ultra-fast, high-intensity lasers to research on the world's polar regions that includes drilling ice cores in Antarctica. Nebraska scientists have played a key role in creating collaboration across institutional boundaries and promoting economic development through research and development investments.

In recent work, Nebraska researchers made a discovery that could help with the treatment of cancer. In studying the nanostructure of gold, they discovered hollow, cage-like structures that are unique in that they can "carry" an atom within the molecule. Unlike previously-discovered carbon molecules (called buckyballs), these cages are made of pure gold. They have the potential for holding "guest" atoms that could be carried to specific areas of the body requiring treatment.



In biomedicine, investigators from the Nebraska Center for Virology are working to better understand the molecular mechanisms that diverse viruses use to cause diseases in people, animals, and plants. For example, scientists are examining how HIV and AIDS-associated cancer viruses cause disease, and they are conducting training to help public health officials detect and prevent disease transmission.

NEVADA

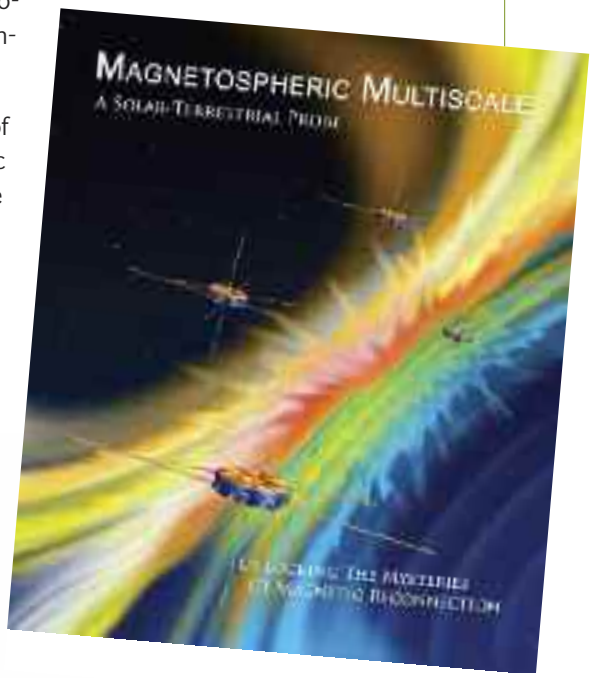
Questions about the origins of life, particularly about the presence of life on other planets or in extreme environments on Earth, are among the topics under study by Nevada investigators. Their work in microbial geosciences involves direct studies of microbial and plant life in Antarctic sea ice and lakes, Chile's Atacama Desert, hot springs in the Great Basin, deep-sea hydrothermal vents, and ancient sub-freezing brines.

A team of Nevada researchers has been studying soil from the extremely dry and virtually rainless Atacama Desert in Northern Chile – a place uniquely Mars-like in that it is highly chemically reactive, appears to be biologically inactive, and contains no plants or algae. This team has found and recovered, for the first time, a significant diversity of bacterial DNA from these soils. The discovery paves the way for the study of life in a Mars-like environment in ways that were not previously possible. The findings may also help explain puzzling, decades-old findings from the Viking mission that landed on Mars and examined its soil directly.

In another study, Nevada scientists, in partnership with teams from the University of New Hampshire, are examining ice cores from Antarctica that are the most detailed record ever produced about greenhouse gases in the Earth's atmosphere. When complete, this record will cover some 100,000 years of climate history. The first phase of this record has been retrieved in a 1,900-foot long ice cylinder, and Nevada investigators are analyzing the dust, chemicals, and air trapped in that sample, which may reveal long-term patterns of climate change.

NEW HAMPSHIRE

New Hampshire's instrumentation and sensor development programs are making possible new discoveries in space, environmental science, nanotechnology, and other research frontiers.



Scientists here are developing sensors for a new generation of small space satellite systems and for atmospheric and aquatic sensor testing in "turbulence-flow" environments. At the same time, they are examining new nanotechnology initiatives to support this research.

New Hampshire also has a new center dedicated to the development of simulation models for studying thermonuclear fusion, and turbulence and heating around the sun. This facility is structured around the premise that certain fundamental aspects of physics – seen in fusion devices, small-scale laboratory experiments, and plasmas around the sun – can be viewed in an interconnected way, and that data examined in one area can provide valuable information about related phenomena in the others.

This Institute for the Study of Earth, Oceans, and Space Science brings together researchers, faculty, staff, and students who have expertise in a broad array of disciplines. They include space science, solar terrestrial theory, engineering, atmospheric chemistry, ocean dynamics and chemistry, biogeochemistry, climate change, paleoclimatology, forest and wetland ecology, hydrology, marine science, and remote sensing of terrestrial and ocean ecosystems.

Recently, the work of some of these scientists — partnered with a team from Nevada's Desert Research Institute – is beginning to reveal the most detailed record ever produced of greenhouse gases in the Earth's atmosphere. The record is contained in a 1,900-foot long cylinder of ice drilled from an ice sheet in Antarctica. The researchers are analyzing the dust, chemicals, and air trapped in the ice, from which they will be able to glean detailed information about atmospheric conditions over the past 40,000 years. As the project continues with more ice cores, the goal is a year-by-year record spanning a total of 100,000 years.

In other work, New Hampshire's researchers recently received $61 million to study the little-understood processes of the Earth's magnetosphere, the comet-shaped shield that protects the planet from solar and cosmic radiation. Another group of scientists has published the first experimental evidence to explain how electrons act during magnetic explosions that occur in such phenomena as solar flares. Understanding this behavior is of great importance because such events have potentially serious consequences for the planet, satellites, and other electronic devices.

State Summaries

NEW MEXICO

New Mexico scientists are at the forefront of the race to create a low-cost, lightweight and flexible solar power source. Researchers at New Mexico State University, with engineering support from Wake Forest University in Winston-Salem, N.C., have created a plastic made from a blend of polymers and carbon molecules that can convert sunlight into electric charges with an efficiency rating notably higher than those previously achieved with such materials in other laboratories. This breakthrough may lead to a solar-generating alternative to photovoltaic (PV) panels that use costly, and increasingly hard to get, silicon. Plastic-based solar-generating material would be cheaper to produce, lighter, and less fragile than PV panels manufactured with silicon. They can be bent to fit on shaped surfaces, such as car roofs, or even sprayed onto irregular surfaces.

In the area of computational sciences, New Mexico researchers have assembled a supercomputer capable of teraflop calculations. This high-performance machine is expected to more fully enable scientists whose research increasingly involves analysis of very large datasets.

New Mexico also has a nanomaterials infrastructure development program. This program emphasizes work at the interface between nanotechnology and biology, as well as programs to examine nanostructured materials for energy conversion. In nano/bio, scientists are experimenting with new ways to produce detailed images of the inner ear and the central nervous system, techniques for screening drugs and pesticides that may interfere with "cell signaling," and nano-level technologies for biomanufacturing. Work related to energy conversion examines the detailed structure of carbon "nanotubes," micro fuel cell technology, new methods for hydrogen production, and electro-mechanical processes for manufacturing very large (i.e., mile-long) photocell panels. New Mexico researchers, in partnership with business and state officials, have forged an alliance with the goal of making New Mexico a leader in a new hydrogen-based economy.

NORTH DAKOTA

Production of jet fuel from crop oil is on the horizon, based on research underway in a North Dakota initiative known as SUNRISE (Sustainable Energy Research, Infrastructure and Supporting Education). Scientists have embarked on a comprehensive program to investigate, develop, and commercialize fuels, chemicals, and polymers from crop oils such as soybean and canola. The aviation industry is not the only beneficiary of this endeavor. As one of the world's major growing regions for oilseed crops, North Dakota will also benefit; the project is advancing science in an emerging field, and it is spurring growth and development in the state's economy. Evidence for this potential is already clear; the first spin-off commercial venture has been launched. SUNRISE Renewables grew out of a university/commercial-partner joint enterprise specifically designed to commercialize biofuel and biopolymer technology developed by SUNRISE researchers.

Other scientists in North Dakota are on a path toward a transformative revolution in electronics. At the Center for Nanoscale Science and Engineering, researchers are studying how to harness one of nature's most fundamental phenomena – the spin of an atom's electrons — which could lead to the next generation of microelectronics. Spin-based computers, for example, would represent a major improvement over those in use today. They would turn on instantly, use far less energy, and would not require a constant energy source.

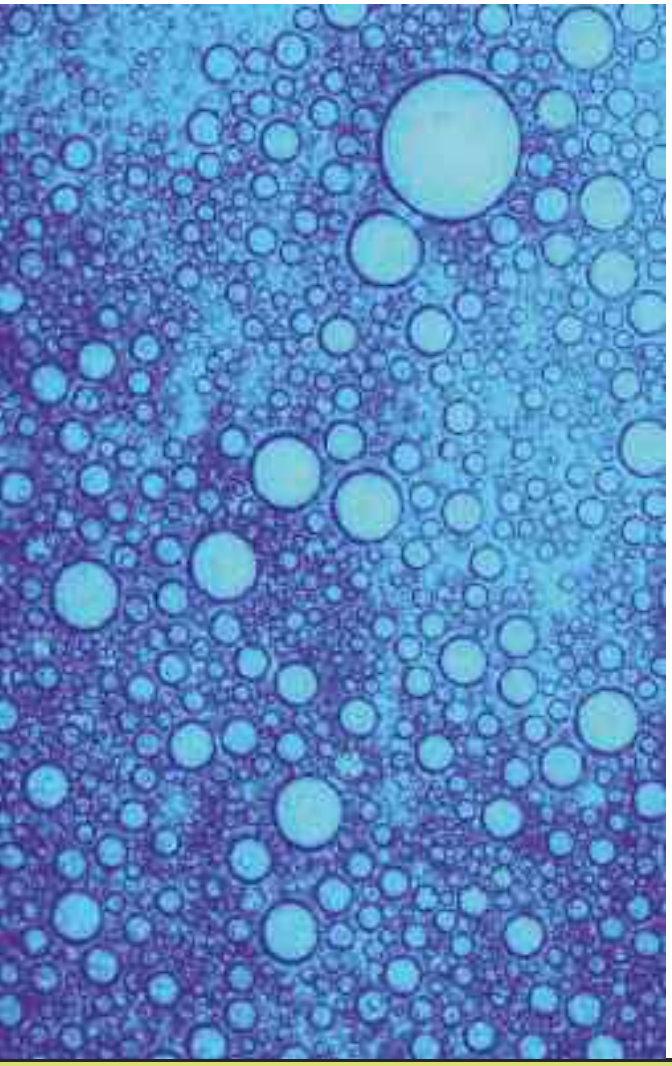
Complementing these research endeavors, North Dakota has implemented an education component that integrates the needs of the business community with the knowledge of science. Through The Plus Experience, college courses target regional industries such as biotechnology, engineering, and software development. These courses are designed by, and geared toward, employers in the private sector. The effort has been embraced by the corporate sector, especially startup companies that often have limited assets available for training new employees.

OKLAHOMA

Ranging from fundamental studies of plant viruses to groundbreaking work in nanotechnology and high-energy physics, Oklahoma scientists are contributing first-class research in an extraordinary portfolio of science, research, and education activities. They are also engaged in a major new thrust in higher education, where they are reforming the undergraduate biology curriculum in the state's regional universities.

Plant science studies are revealing information previously unknown about viruses – both benign and potentially dangerous – and how they interact with their natural hosts. Such work has significant implications for understanding emerging plant diseases and how to control them. In other areas, work on solar energy is focusing on potentially low-cost, carbon-based nano-structures that could lead to a new class of photocells.

In the field of biomedicine, Oklahoma researchers are conducting major projects in microbiology, immunology, oncology, and neuroscience. Studies aimed at understanding the structure and function of genes and proteins are using advanced, computer-aided statistical analysis and animal imaging that takes advantage of state-of-the-art MRI technology. Coupled with this research is an outreach program designed to increase the number of undergraduates involved in science, technology, engineering, and mathematics.



PUERTO RICO

Puerto Rico EPSCoR has led to an island-wide program in nanoscience and nanotechnology. Ten years of work and planning came to fruition with the funding of the Institute for Functional Nanomaterials (IFN) by EPSCoR in 2007. One of the institute's key strategies is to forge strategic alliances. IFN has developed partnerships with academia (Purdue University, University of Massachusetts, Cornell University, SUNY-Binghamton, Northwestern University, and Rensselaer Polytechnic Institute) and with federal research centers (DOE Argonne National Laboratory and NASA Glenn Research Center). The alliances provide valuable collaborations among researchers, particularly in the innovation phase of the development process. A new initiative in nano-biotechnology is currently being explored with Rice University as a potential partner.

Recent studies have focused on the response of suspensions of magnetic nanoparticles — minuscule magnets dispersed in a fluid medium — to time-varying magnetic fields. Other projects use nanotechnology to develop improved power systems for space exploration. This work leverages strong alliances with NASA's Glenn Research Center. A Department of Energy partner, Argonne National Laboratory, joined with the University of Puerto Rico to begin a new effort through DOE-EPSCoR for research in the emerging field of spintronics. With numerous other awards already received from multiple federal agencies, Puerto Rico's scientists anticipate building an even stronger research and development enterprise in nanoscience and nanotechnology.

State Summaries

RHODE ISLAND

A new research center that focuses on cartilage and joint health – and ways to repair damage to those areas – has been launched in Rhode Island, adding another dimension to a diverse portfolio of biomedical research programs underway by scientists in that state. This work, along with novel projects examining how tissues heal, reflect the great promise for Rhode Island's biomedical sciences initiatives.

In one such study, researchers are looking at how the brain repairs damage caused by antipsychotic drugs. Other studies underway are aimed at transforming our understanding of "signals" that cause certain types of cancer to grow, while a third line of work studies biological processes, such as heart and lung development, just before and after birth.

Life Sciences research in Rhode Island focuses on molecular, marine, and environmental bioscience. Researchers here have found what may be the first scientific link between warming and fundamental changes in marine nutrient cycles. Most significantly, their study led to an unprecedented finding of high rates of "nitrogen fixation" – an essential stage in the cycle of life and the ultimate source of all nitrogen in living organisms.

SOUTH CAROLINA

Current sensor technology enables the rapid collection of massive amounts of data. However, limited capabilities for extracting, understanding, and acting on huge datasets can limit their potential value. One area where this is of special concern is in national security and defense applications, such as those involving navigation of "self-guided" vehicles. Scientists at South Carolina's Industrial Mathematics Institute are developing solutions to this dilemma. They are examining fundamental new approaches for delving into data sets and immediately extracting useful information. Their studies have the potential to revolutionize the real-time examination of sensing data, not only in navigation applications, but in other circumstances where thorough and rapid data-analyses are required.

South Carolina researchers are also contributing significantly to work in biomedicine where they are developing the next generation of technology for monitoring heart function in infants. Traditional cardiac catheters used in infants can move around excessively, causing inaccurate readings and sometimes creating complications when they are removed. At The Medical University of South Carolina and at Clemson University, teams of scientists are studying implantable wireless devices that can measure pressure and tension in the heart following surgery. These novel devices have the potential to significantly reduce side effects now associated with traditional catheters in infants, while providing accurate sensing capability.

SOUTH DAKOTA

South Dakota is integrating the culture of research and teaching in its path to world-class accomplishments in science, technology, engineering, and mathematics. Results of this commitment have led to highly respected work in biomedicine, nanoscale science, and photo-active systems.

For example, a group of some 40 faculty members have united to conduct innovative work in solar energy, where discoveries focus on improving the performance of solar cells and light-collecting technology. Through this photovoltaic research, South Dakota scientists have the potential to fundamentally enhance the performance of solar devices, which will lead to less expensive and more efficient ways to convert sunlight to electricity. Other work by members of this group focuses on emerging technology that allows electronic circuits to be printed directly onto flexible materials such as plastic and paper.

In the field of biomedicine, South Dakota scientists are working on research that will one day help people who have suffered brain injury. They are examining how the brain "rewires" itself after debilitating disease or injury. By discovering how this fundamental reorganization of neural circuitry takes place, scientists can better understand what happens during learning and memory – and during the central nervous system's response to stress and anxiety states, and to injury such as that occurs during stroke and Alzheimer's disease.

TENNESSEE

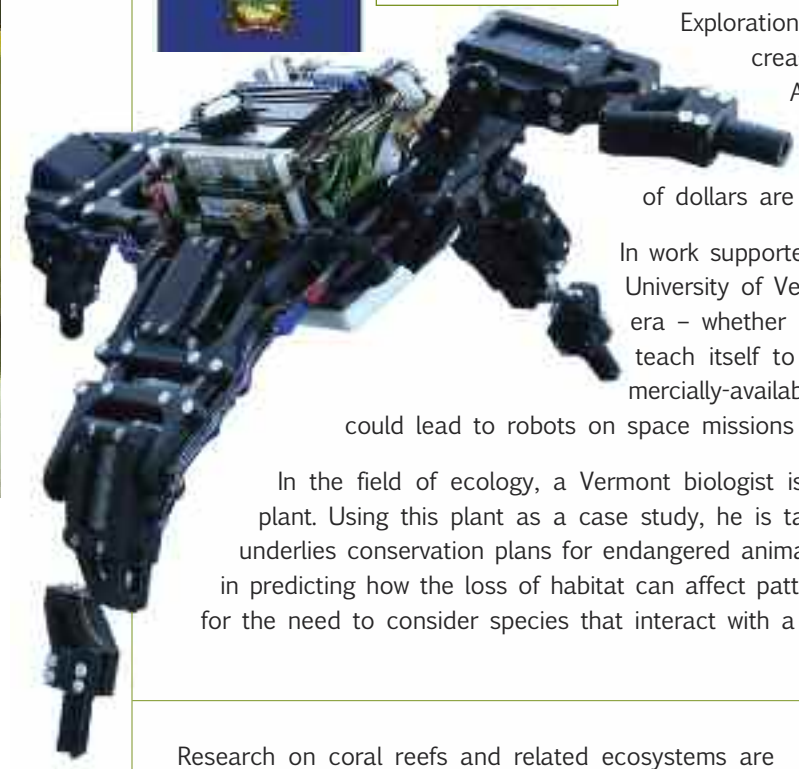
Federal support through the EPSCoR/IDeA program has enabled Tennessee scientists to make major accomplishments across several areas of science and engineering, including notable achievements in Biomedical/Health Sciences, Environmental Science and Engineering, Materials Science, and Computational Science and Applications.

In one such initiative, Tennessee researchers have embraced the theme "Novel Nanomaterials for Energy and Sensing Applications" by focusing on three strands – novel nanomaterials, nanotechnology-based sensors, and nanomaterials for energy solutions. The state is working toward the major goals of increasing intra-state collaboration in these research areas and implementing the state Science and Technology plan – *Tennessee Innovation Road Map*.

Successful research has also contributed to a statewide cyberinfrastructure plan. The state is implementing a high-speed link connecting the three high-research universities and Oak Ridge National Laboratory. This $3-million investment recognizes the state's long-standing accomplishments and establishes a commitment to future advances in research and education. Awareness of the relationship between competitive research and economic development has increased greatly, and there have been substantial collaborations, particularly in Materials and Energy science. Three independent initiatives are now underway to develop cyberinfrastructure for this research and education, as well as to increase the availability and adoption of broadband technologies in all regions of Tennessee.

State Summaries

VERMONT



Exploration of planets, moons, and even other remote places on Earth, increasingly relies on robots. But what happens when they are injured? According to one Vermont scientist, they have to "be able to fix things on their own." If they are very far from Earth, and cannot communicate the problem back to their controllers, millions of dollars are lost unless they are able to heal themselves.

In work supported by NASA, members of the computer science department at the University of Vermont have built a robot that is able to detect – without a camera – whether something mechanical is wrong and how to repair itself. It can teach itself to walk again despite the damage that has occurred. Using commercially-available robot construction kits, these scientists' state-of-the-art research could lead to robots on space missions that can continue their work without human intervention.

In the field of ecology, a Vermont biologist is doing equally significant work through his study of the pitcher plant. Using this plant as a case study, he is taking a comprehensive approach to the population modeling that underlies conservation plans for endangered animals and plants. His work focuses on the importance of food webs in predicting how the loss of habitat can affect patterns of population change. The project has important implications for the need to consider species that interact with a target species to fully understand population dynamics.

U.S. VIRGIN ISLANDS

Research on coral reefs and related ecosystems are the primary research areas being examined by scientists in the U.S. Virgin Islands. Through work at an expanding center of excellence in marine and environmental science, a program on Biocomplexity of Caribbean Coral Reefs (BCCR) examines the marine environment of the Virgin Islands.

BCCR researchers conduct nationally-competitive research in oceanography, biodiversity, and the ecology of the area's complex coastal ecosystems. The interdisciplinary research program provides an opportunity to synthesize local research and to formulate an integrated ecosystems management approach to ensure the wise stewardship of the territory's marine resources. Partners include other universities, government agencies, and private organizations.

In related work, scientists in the field of genetics focus on the molecular phylogenic analysis of the Virgin Islands coral (*Porites*), the genetic diversity of long-spined sea urchins, and some of the metabolic markers for bleaching in *Porites.* Other scientists are analyzing coastal science data, while still others work on mesoscale weather modeling that integrates studies of the effects of watershed-activity patterns and coastal processes on near-shore coral reefs.

The Virgin Islands research portfolio also includes the development of a regional tsunami warning system; ecosystem dynamics (including an assessment of the relationship between habitat and parasite infestation in reef fish); studies of the influence of coastal current patterns on disease susceptibility and connectivity of endangered coral; marine natural products (including novel anticancer metabolites from marine sponges); and biological interactions at the surface of advanced fouling-release marine coatings.

WEST VIRGINIA

The discovery involved "a bit of luck," according to a member of the West Virginia University physics team that found a new astronomical phenomenon – powerful, short-lived bursts of radio waves. This finding may reveal an important new way to determine the amount of matter in intergalactic space. While looking at data from pulsars (stars that emit energy at regular intervals) the scientists identified these short-lived signals, which lasted less than five milliseconds and appear to have originated from the distant universe. They may have been produced by an exotic astronomical event such as the collision of two neutron stars or the death throes of an evaporating black hole. The implications of this research are especially significant because it could open a whole new field of study, comparable to that which emerged around the study of gamma rays.

Equally groundbreaking is the work of another West Virginia scientist whose studies have revealed how common, normally benign bacteria can become deadly. The microorganism *Pseudomonas aeruginosa* is naturally present in the environment and is usually harmless. However, it can alter its structure and produce a thick, slimy "biofilm" that protects it from the body's immune defense mechanisms. This result can be life threatening, especially when it occurs in the lungs of patients with diseases such as cystic fibrosis. This work has received broad, multiagency and foundation support and has the potential to produce significant health and economic benefits to West Virginia.

Two other programs in West Virginia, focusing on nanotechnology and biometrics, are also geared toward building infrastructure and developing the state's economy. WVNano has developed structures to coordinate and share resources across the state. This effort also includes mechanisms for protecting intellectual property and exploring commercial opportunities presented by research programs. The other work is directed toward developing a world-class research capacity in biometric applications. This research could lead to robust, low-cost instruments with multiple applications in homeland security, health, forensic science, and other fields.

State Summaries

WYOMING

How do sensory experiences early in life affect the brain's ability to properly "wire" itself? What are the effects on "brain maturity" — and normal, healthy development — when environmental stimulation is absent during critical periods of neurological growth and development? Scientists at Wyoming's Laboratory of Neural Development and Learning are answering these questions through work conducted in EPSCoR/IDeA-supported programs. Such studies hold great promise for protecting against potentially irreversible developmental delays in humans and could lead to the discovery of therapeutic interventions to promote recovery from disease and trauma.

Research on such fundamental research questions is but one of many initiatives underway in Wyoming in diverse scientific areas including energy, physics, and astronomy. As the nation's foremost energy-producing state, Wyoming has positioned itself to be a leader in research associated with fossil fuels, electrical energy resources, and environmental remediation processes.

The state has also demonstrated its commitment to taking advantage of its research accomplishments and transferring that fundamental science to innovation in the business community. In recent years, Wyoming has markedly increased the resources it receives to conduct innovative research and technology programs from federal sponsors and has institutionalized such efforts through a newly-established Wyoming Business Council.

EPSCoR/IDeA

Contributions to Areas of National Importance

The following section provides selected examples of the diverse ways that the EPSCoR/IDeA jurisdictions contribute to and advance the nation's research and education agenda.

Basic Science and Engineering

Integrated Research and Education Effort

ALABAMA

A significant element in building both research capacity and capability involves development of graduate students, and the Alabama Commission on Higher Education and the Alabama EPSCoR program have launched a Graduate Research Scholars Program to fulfill this objective. All seven Alabama research institutions are involved in this effort, which has attracted a diverse population of students. Alabama has also linked EPSCoR with their NSF-funded Louis Stokes Alliance for Minority Participation (LSAMP) program where participants have contributed papers and presentations in a wide-ranging portfolio of topics, including disaster planning, materials research, nanoscience, and the imaging and detection of cancer.

In work supported by the Department of Energy, Alabama researchers are engaged in studies of fuel cells. This project, with a focus on nano-structured catalysts, has enabled participation by numerous faculty members in this highly interdisciplinary and intercampus activity.

Science-Driven Problems and Enhanced Cyberinfrastructure

LOUISIANA

A $9 million NSF EPSCoR grant is enabling a team of researchers from nine Louisiana universities to capitalize on the state's recent sizeable investments in cyberinfrastructure by developing new cyber tools for high-performance computing, advanced networking, and data management capabilities. Recognizing that the cyber tools cannot be built in isolation from the scientific projects, Louisiana researchers are developing cyber tools in tandem with the project's science drivers.

Science Drivers for this effort include the need for simulation, design, and manufacturing of miniaturized antibody-based sensors that, for example, detect chemical elements associated with a variety of chemical and biochemical targets, and bio- and environmental-transport processes, including improved forecasting technologies for catastrophic environmental events such as hurricane storm surges.

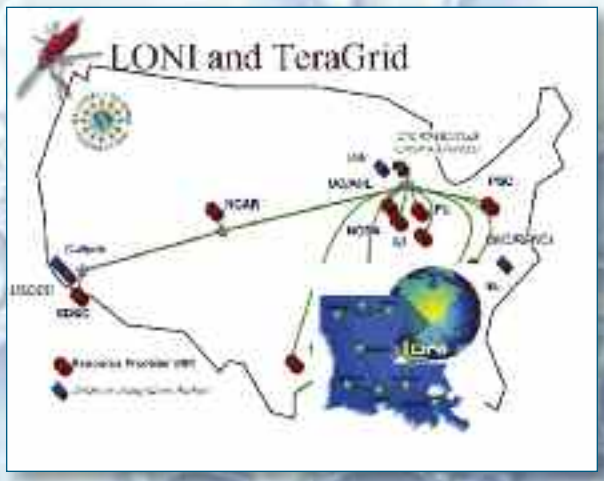
The cyber tools program, called Cybertools WorkPackages, addresses the Science Drivers' common needs in theory and methodology, in the development of well-defined computational plans, and in the cyberinfrastructure required to advance them in a 21st century computing environment.

In Faculty Development and Outreach, a suite of integrated programs — updated periodically to respond to changing needs — are designed to stimulate long-term research competitiveness of tenured and tenure-track junior faculty, and to engage Louisiana's large population of underrepresented minorities in science and technology careers.

Each of the three components of the Louisiana EPSCoR RII grant (Cybertools, Science Drivers, and Faculty Development and Outreach) are dependent on one another. The multi-functional Cybertools will be developed in association with the Science Drivers projects, while the education and outreach activities are highly integrated into this process and into each Science Driver and Cybertools component.

In addition, Louisiana's investments in biotechnology provided substantial resources to enable higher-education research groups to undertake state-of-the-art biotechnology research while the state's cyberinfrastructure investments have fostered both research and economic development. Louisiana has attracted several digital arts and gaming companies, and is now considered the second leading state, behind California, for advanced film production, including animation.

The Louisiana Optical Network Initiative (LONI) creates a research gateway to the world via the National LambdaRail (NLR) optical network. LONI and other advanced tools allow scientists to conduct many more tests in a much shorter period of time and with better results than traditional screening. In September 2007, the National Science Foundation selected LONI to become a TeraGrid partner as a new resource provider, and on October 1, 2007, Louisiana officially joined TeraGrid. LONI will contribute one-half of the computational cycles of its super computer (Queen Bee) to support the national research community. In exchange, NSF is providing $2.2 million in funding for additional support of the machine and the new set of users, as well as additional network connections from LONI to the rest of the TeraGrid. This partnership gives LONI researchers an easier path to make use of additional national supercomputing capabilities. LONI is one of only 11 nationwide NSF-selected TeraGrid partners. Queen Bee, the State's 50 teraflop supercomputer, is the 23rd most powerful supercomputer in the world and fourth among U.S. universities, according to the annual *Top 500 Supercomputer Sites* released in early July.



Another major achievement for Louisiana scientists and engineers has been the tremendous growth in capabilities for NASA-related astrophysical research with the establishment of a competitive sub-orbital balloon flight program and the associated instrumentation. From its locus at Louisiana State University and Southern University Baton Rouge, the interest and capabilities have been expanding outward to other universities in the state, based largely upon the infrastructure development activities of EPSCoR and Space Grant. In addition to the balloon and space experiments, the Laser Interferometer Gravitational Wave Observatory (LIGO) facility continues to break new ground in gravity wave research, while the Pierre Auger Observatory (AUGER) project studies the highest energy particles found anywhere in the galaxy.

Competitive Collaborative Research and Education Programs

MISSISSIPPI

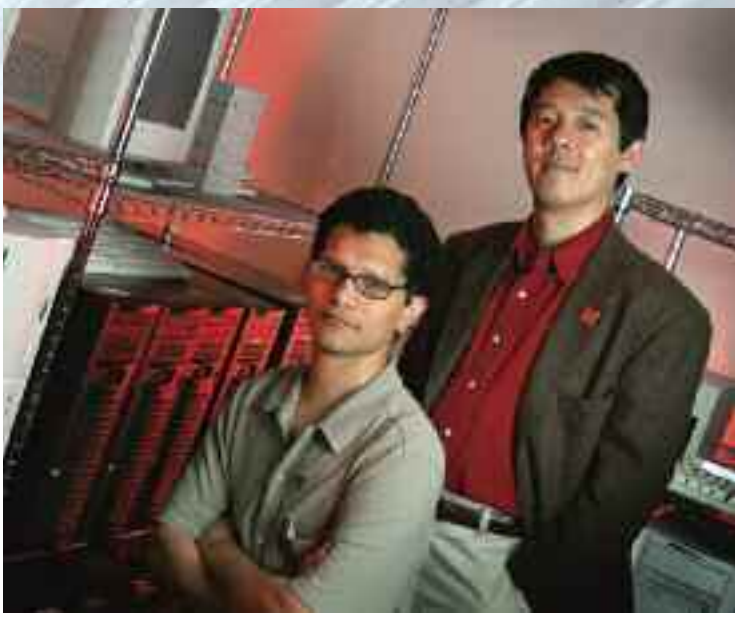
At the onset of EPSCoR in the mid-1980s, Mississippi recognized the power of collaboration. The Vice Presidents of Research at the state's four research universities came together to form the Mississippi Research Consortium (MRC) in 1986. Its goals were: (1) to develop a research infrastructure to support education and extend technology development in Mississippi; (2) to foster research funding opportunities and increase interaction with federal agencies; (3) to develop and share resources; (4) to improve science education opportunities for students elementary through college; (5) to make the most of human potential and provide technical assistance; and (6) to enhance economic opportunities for the state. Evidence that the MRC is working lies in the fact that the state is successful in a variety of fields – polymers, high performance computing, and computational biology. The state has been equally successful in its education and outreach efforts, particularly in the critical field of computational sciences.

The education and outreach initiative focuses on recruiting and retaining promising students in computational majors at Mississippi's research institutions. The approach is to develop and expand programs that include partnerships among Mississippi's institutions of higher learning. The program also provides secure pathways for students in computational science majors with intervention at various levels, from high school to a baccalaureate degree, and onto graduate school. Research is a key component. Graduate and undergraduate students in the program use computational research tools in biology, chemistry, and engineering. Much of this research is possible through the collaborative efforts of faculty from different institutions. This creates an opportunity for all students, including under-represented minority students from all institutions, to be involved in a variety of projects and to be trained by a diverse faculty. This type of cross-institutional collaboration will grow to include all research thrusts and related areas, other institutions of higher learning, and other regional historically-black colleges and universities (HBCUs).

Although all member institutions enroll a significant number of under-represented minority students, Jackson State University, as the four-year research HBCU, has the most experience and success in recruiting and retaining minority students in the sciences. Collaborative efforts and lessons learned at Jackson State are shared among institutions and are extremely valuable to the pursuit and success of any education and outreach endeavor. Efforts include curricula additions, bioinformatics workshops for high-school and college instructors, classroom demonstrations, degree/certification program plan development, computational science module design and implementation, scholarships, computational science curricula pathways, and a host of other strategies, including the NSF-funded Louis Stokes Alliances for Minority Participation (LSAMP) program and other agency minority-focused programs.

Major Centers of Excellence in Materials

NEBRASKA



In Nebraska, the NSF-funded Materials Research Science and Engineering Center (MRSEC) has generated important fundamental research in nano-technology focusing on quantum and spin phenomena in nanomagnetic structures. Newly-discovered nanoscale structures with exceptional properties represent one of the most dynamic and exciting areas in science and technology. The emergence of nanoscience and nano-technology has brought to the fore the concepts of deliberate fabrication of composite structures by either "bottom-up" or "top-down" methods.

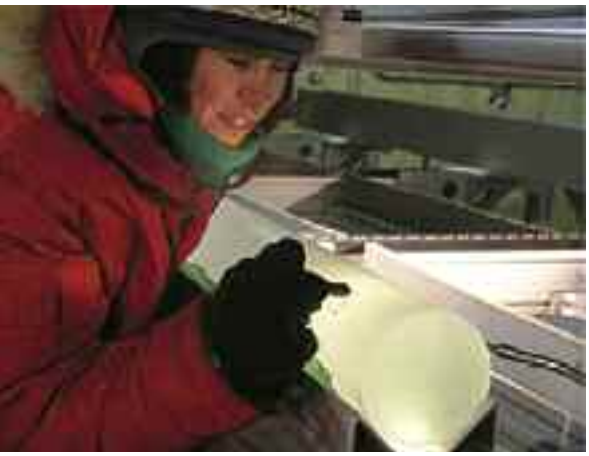
The top-down method has worked well for decades in the miniaturization process but is reaching its limits. The bottom-up method relies on the principle of self-assembly or self-organization, and has great potential for creating nanoscale systems that possess completely new properties. Future research likely will involve combined top-down and bottom-up approaches. Many new phenomena and devices are under study with these ideas, including giant magnetoresistance sensors, high-density data storage and memory, spintronics, and exchange-coupled nanomagnets.

One focus area involves the study of exchange and magnetostatic interactions between particles or grains in nano-structures. Understanding these interactions is a fundamental problem in magnetism and spin electronics, and is of technological importance in areas such as magnetic recording media, magnetoresistive sensors, and permanent-magnet materials. Since nonlocal, nonlinear, and nonequilibrium effects play important roles in nano-structures, the atomic origin of their magnetism requires relativistic quantum-mechanical solutions for very complex interfaces and boundaries.

Education and outreach are important components of Nebraska's research portfolio, and very young students are among the beneficiaries of this commitment by the state's investigators. For example, MRSEC researchers visited Clinton Elementary School to help students investigate the optical and electrical properties of solids. Here, fourth-grade students did several hands-on experiments involving electrical measurements, optical reflection and transmission, and observations of the refractive properties of transparent material.

Microbial Ecology and Life in Extreme Environments

NEVADA



Nevada EPSCoR activities during the past five years have led to a deliberate and extensive transformation of research and education in the areas of microbial ecology and life in extreme environments in several institutions in Nevada's System of Higher Education (NSHE). For example, Nevada's NASA and NSF EPSCoR programs have promoted studies related to biological responses to abiotic stresses and astrobiology.

In doing so, these programs have built infrastructure and expertise in the microbial geosciences, which have fostered direct studies in a number of areas, including microbial and plant life in Antarctic sea ice and lakes, microbial life in the Atacama desert, microbial life in the Great Basin's hot springs, genomes of symbiotic microbes and their hosts in deep sea hydrothermal vents, microbial survival and growth in ancient subfreezing-brines, and the search for water and life on Mars. All of these studies have drawn from multiple sources of funding outside of the EPSCoR program and have contributed to the nation's science and technology development agenda that seeks to evaluate the fundamental constraints and limits to life's existence, as well as the potential for life's existence beyond our home planet.

By directly fostering these studies and developing the expertise in Nevada to study these topics, the EPSCoR programs of NASA and NSF also have indirectly allowed the state's institutions to attract additional faculty and strengthen capacity to undertake research and education in an array of applied research topics, such as the evaluation and management of water quality in Nevada's rivers, endocrine disruptors in freshwater ecosystems, biodegradation of pollutants in aquatic systems, systems-engineering for algae to bio-diesel production, generation of electricity from anoxia, management and treatment of acid-mine drainages, and the protection of drinking-water resources from harmful cyanobacterial/algal blooms.

New faculty who have joined NSHE institutions over the past several years have enabled many of these studies and topical areas to flourish. They have joined departments from across the state in transforming NSHE into a system that values and supports basic research regarding fundamental questions in the life sciences, as well as applied research that is relevant to sustaining and bettering the everyday lives of people around the world.

Institute for Functional Nanomaterials

PUERTO RICO

Funding from Puerto Rico EPSCoR has made possible an island-wide program in nanoscience and nanotechnology. Led by a recent RII award from the NSF to develop an Institute for Functional Nanomaterials (IFN), the entire enterprise is testimony to what EPSCoR can accomplish when it is applied systemically. For the past 10 years, the University of Puerto Rico's Resource Center for Science and Engineering (the umbrella organization that administers EPSCoR efforts in Puerto Rico) has been nurturing the human resources and research infrastructure necessary to develop a sustainable competitive enterprise in nanoscience and nanotechnology.

The effort came together at the end of 2005 when 28 scientists and engineers from four UPR campuses came together to form the IFN, which was subsequently funded by NSF in June 2007. The IFN, under the able leadership of PR-EPSCoR co-directors Dr. Brad R. Weiner and Dr. Manuel Gomez, is designed to provide the continuity and infrastructure for nanoscience and nanotechnology efforts in Puerto Rico, and to foster synergy between the ongoing research and development effort and the innovation and economic development sectors on the Island.

One of the key strategies of the IFN is to forge strategic alliances. Today, the institute has developed partnerships in academia (Purdue University, University of Massachusetts, Cornell University, SUNY-Binghamton, Northwestern University, and Rensselaer Polytechnic Institute) and with federal research centers (DOE Argonne National Laboratory and NASA Glenn Research Center). These alliances provide valuable collaborations for IFN researchers, particularly in the innovation phase of the development process. A new initiative in nano-biotechnology is currently being explored with Rice University as a potential partner.

Today, the IFN is fully operational and has become the centerpiece of PR-EPSCoR's development strategy. Dr. Carlos Rinaldi, Professor of Chemical Engineering at UPR-Mayaguez, was recently given a PECASE award for his research on the response of suspensions of magnetic nanoparticles — minuscule magnets dispersed in a fluid medium — to time-varying magnetic fields. Dr. Gerardo Morell, Professor of Physics at UPR-Rio Piedras, led a group of professors who recently received a NASA EPSCoR award to use nanotechnology to develop improved power systems for space exploration. This project leverages the strong alliance with NASA's Glenn Research Center. Puerto Rico's Department of Energy partner, Argonne National Laboratory, joined with the UPR to submit a new effort through DOE-EPSCoR for research in the emerging field of spintronics. With numerous other awards already received from multiple federal agencies, Puerto Rico's plan to build a competitive research and development enterprise in nanoscience and nanotechnology is becoming a reality.

Deep Underground Science and Engineering Laboratory

SOUTH DAKOTA

The National Science Foundation (NSF) recently announced selection of University of California-Berkeley as the project lead with South Dakota institutions and others, including international partners, to produce a technical design for a Deep Underground Science and Engineering Laboratory (DUSEL) at the former Homestake gold mine near Lead, South Dakota. The Homestake team, headed by Kevin Lesko, could receive up to $5 million per year for up to three years.

The selection was made by the NSF after an exhaustive merit-review of proposals from four teams who unanimously determined that the Homestake proposal offered the greatest potential for developing a DUSEL. The agency's selection of the Homestake proposal provides funding only for design work at this time. "We are excited about the opportunities in underground research and education that a DUSEL would provide and look forward to working with all of the research communities to develop a well-conceived plan for this unique, world-leading facility at the Homestake Mine," said Tony Chan, assistant director for the NSF Directorate of Mathematical and Physical Sciences. "In tandem with the design of the facility infrastructure, NSF also will begin working with researchers to identify the initial suite of experiments that might be deployed in DUSEL." This first step represents a major potential opportunity for scientists in South Dakota to be part of a world-class international team working on transformative research projects.

The concept of DUSEL grew out of the need for an interdisciplinary "deep science" laboratory that would allow researchers to probe some of the most compelling questions in modern science. Among them: What are the invisible dark matter and dark energy that comprise more than 95 percent of everything visible in the universe? What is the nature of ghostly particles called neutrinos that pervade the cosmos, but almost never interact with matter, and what can certain kinds of extremely rare radioactivity and particle decay reveal about the fundamental behavior of atoms? Will this site help reliably predict and control earthquakes? What are the characteristics of microorganisms at great depth?

Those and other crucial questions can only be investigated at great depth, where thousands of feet of rock can shield ultrasensitive physics experiments from background activity, and where geoscientists, biologists and engineers can have direct access to geological structures, tectonic processes and life forms that cannot be studied fully in any other way. Several countries, including Canada, Italy and Japan, have extensive deep-science programs. The United States has no existing facilities below a depth of 1 kilometer. If eventually built as envisioned by its supporters, a Homestake DUSEL would be the largest and deepest facility of its kind in the world.

Source: NSF Website

Novel Nanomaterials for Energy and Sensing

TENNESSEE

The general statewide research theme for Tennessee NSF EPSCoR is Novel Nanomaterials for Energy and Sensing Applications. There are three thrust areas: 1) Novel Nanomaterials; 2) Nanotechnology-based sensors; and 3) Nanomaterials for energy solutions. As part of the Tennessee Innovation Road Map, materials science and nanoscience are identified as targets of opportunity.

Research funds are allocated to the three high-performing research universities: The University of Memphis, The University of Tennessee-Knoxville and Vanderbilt University. Increased accessibility to research equipment at participating institutions, as well as at Oak Ridge National Laboratory, are important features of this work.

In defense-related efforts, projects are aimed at work in a Computational Model for Biologically Inspired Distortion Invariant Automatic Target Recognition, Resonant Ultrasound Studies of Magnetorestrictive Materials, and Size-selective Toxin Detection Using Nanoscale Porous Silicon Biosensors. The goal of initiatives in space sciences is directed at providing seed funding that will enable institutions to develop an academic research enterprise directed toward long-term, self-sustaining, nationally competitive capabilities in aerospace and aerospace-related research.

EPSCoR/IDeA

Health

Asian Avian Influenza

ALASKA

The fear that gripped the world with the reemergence of H5N1 influenza, remembering the devastation of the 1918 pandemic flu, fueled the rapid research response on the Fairbanks campus of the University of Alaska. Dr. George Happ, Dr. Jonathan Runstadler, and Dr. Falk Huettmann initiated an international collaboration with Russia, Japan, and the United Kingdom. Now entering its second year and field season, the collaborative team is collecting cloacal fecal samples from migrating birds to analyze for the presence of the influenza virus.

In the first year, six international collaborators took more than 6,000 samples. In the 2006 season, challenges arose, ranging from difficulty getting samples shipped back to the United States, to samples coming back without fixative media. Flexibility in approach, therefore, became critical to nurturing fragile relationships. Positive responses to problem solving in the face of unexpected barriers became part of the team's normal daily activities and created opportunities for expanded collaborations. The team met in February 2007 to review procedures and establish improved systems for 2007.

In the second season, the size of the international collaborative collection teams was increased by two more ornithologists and the addition of in-country screening at world-class laboratories, to which historically the University of Alaska would not have had access. The planning meeting for 2008 will be in Japan and will include the nine international and three American scientists and three directors of laboratories in three nations that will run the 2007 samples.

All of this has resulted from the scientists' developing new relationships beyond the confines of their own comfortable laboratories. The team, now known as Alaska Asian Avian Influenza Research (A3IR), has risen above the perceived challenges of language, culture, and international politics to pursue a common passion – striving to understand the science of avian influenza.

Dr. Runstadler stated it best in an interview in 2005: "No one knows if H5N1 is going to be a pandemic or epidemic problem, or if it's just going to fade away. If it fades away, there will be another virus that will be an issue. I don't know when – maybe next year, maybe 20 years or 30 years from now. There's going to be one that becomes human-adapted for transmission and it's going to make people sick. Hopefully by then we'll have better health-care systems and a better understanding of the biology of the virus so that we'll be able to effectively contain an epidemic and perhaps even predict its emergence and avoid it."

From Research to Clinical Studies to Medical Practice

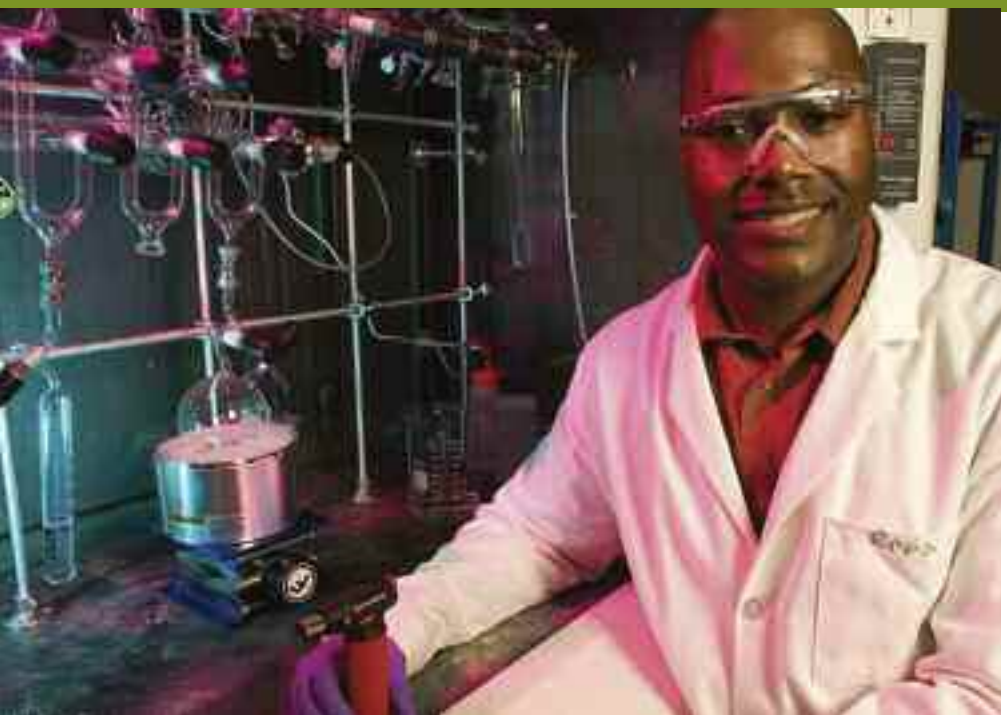
ARKANSAS

Congressional leaders, policy-makers and the public at large are increasingly concerned that the scientific discoveries of the past are failing to be translated into tangible benefits to public health. The response has been a series of initiatives making translational research a priority. However, two blocks to translational research have been identified, a lack of translation of basic science discoveries into clinical studies and then from clinical studies into medical practice. Arkansas scientists have designed the Center for Translational Neuroscience (CTN) to address the blocks to both of these processes, while mentoring promising scientists toward careers in translational research.

The establishment and maintenance of a strong translational neuroscience program is essential to the continued growth of research at the University of Arkansas for Medical Sciences (UAMS), as well as to the benefit of the citizens in the state. The impact this program has had on a small institution has been greater than that at larger universities. The CTN is becoming a beacon for translational research in the region, and is already having a significant impact on the health of its constituents.

Neuroscience research at UAMS has been built on infrastructure development programs headed by Dr. Edgar Garcia-Rill. These included EPSCoR I in 1980-85, which increased funding from $200,000 to $2.5 million and helped investigators secure federal funding, and EPSCoR II in 1990-95, which helped recruit new faculty and raised grant income from $2.5 million to $12 million. This second award led to the establishment the Center on Aging and the Center for Neuroscience. The first round of NIH COBRE funding at UAMS was also a catalyst for improving the research infrastructure in translational neuroscience and encouraging clinician scientists to pursue research careers.

The Career Development Program at the CTN and the new Community Based Research and Education Core Facility became models for a UAMS application for a Clinical and Translational Science Award (CTSA). Among the research accomplishments noted in that application was a new and effective treatment for tinnitus, the development of a device – as well as a new drug treatment – for hyper-reflexia, and a cure for "spatial neglect." Arkansas scientists also discovered a novel mechanism for sleep-wake control that will impact the mechanisms behind anesthesia, and they have begun to decrease the death rate among low-birth weight babies in the state.



Biomedical Cancer Research

DELAWARE

One of the strategic goals of Delaware NIH IDeA is to establish biomedical research capability, with an initial focus on cancer. Because Delaware does not have a medical school, the program decided to develop basic, translational research capability by establishing what would later be called a "virtual medical school." The concept builds on the significant expertise in place at clinical and academic institutions across the state, and brings their strengths together into a unique structure. Several successful initiatives have been launched over the past two years.

With support provided by NIH/NCRR through the Delaware INBRE program, the Center for Translational Cancer Research (CTCR) was founded in 2006. This endeavor represents a collaboration between the University of Delaware, the Delaware Biotechnology Institute, the Helen F. Graham Cancer Center at Christiana Care, and Nemours Biomedical Research at the A.I. duPont Hospital for Children.

The mission of CTCR is to establish a pipeline of translational cancer researchers and clinicians by developing a program that starts at the undergraduate level and continues training throughout the graduate and post-graduate levels. CTCR seeks to build research partnerships by constituting teams of clinicians, biologists, engineers, chemists, and computer scientists to attack cancer-related problems.

In 2007, the Helen F. Graham Cancer Center at Christiana Care was selected as one of 14 initial cancer programs chosen by the National Cancer Institute (NCI) to launch a strategic initiative that will greatly extend access to NCI-sponsored clinical trials around the country.

The NCI Community Cancer Centers Program (NCCCP) enters a three-year pilot phase now with a view toward rolling out the program nationwide in 2010. The NCCCP pilot focuses on:

- expanding clinical trials, especially in minority communities;
- reducing disparities in cancer health care;
- collecting, storing, and sharing tissue and blood samples for research; and
- exploring the use of a national database of electronic medical records.

The designation as a NCCCP gives national recognition to Delaware's effort to build on its diverse research community to bring together clinicians from the medical community and researchers from the academic community. The NCCCP program has a special emphasis on underserved populations – including elderly, rural, inner-city and low-income patients – as well as racial and ethnic groups with unusually high cancer rates. To this end, Christiana Care's Community Clinical Oncology Program (CCOP) plays a critical part in enrolling patients in clinical studies of every major type of cancer.

The Cancer Center is focused on a multidisciplinary approach to treatment, along with translational cancer research to maintain clinicians on the cutting edge of future cancer care, while providing access to clinical trials and screening and prevention programs critical to cancer patients. The NCCCP will help the Center for Translational Cancer Research attract more first-class scientists and MD/PhDs.

Healthcare Sensors for Basic Environmental Research

HAWAII

In research conducted by scientists in Hawaii at the University of Hawaii-Manoa (UHM) and University of Hawaii-Hilo (UHH), an innovative new sensor system called Intelesense promises to advance public health across many fronts. Environmental factors and public health are often inextricably linked, and waterborne illnesses affect millions of people worldwide, especially in remote, undeveloped areas. According to the United Nations Development Program (UNDP), 80 percent of human illness in rural areas is caused by waterborne disease or pollution. For example, 32 million people (about 36 percent of Vietnam's population of 90 million) do not have access to clean water. According to the UNDP, the situation is similarly appalling worldwide, with 5 million people dying every year because of waterborne illness, which is also implicated in 60 percent of infant mortalities.

As part of a collaboration with the University of Hawaii, the U.S. Department of Health and Human Services, the U.S. Army Medical Research and Materiel Command's Telemedicine and Advanced Technology Research Center, the Vietnamese Academy of Science and Technology, and the Hanoi School of Public Health, Intelesense is deploying an advanced system of environmental monitoring sensors that will be integrated with public health data to research how waterborne illnesses form.

This project recognizes the importance of being able to link environmental factors with public health data. As one researcher has explained, "If we could show that humans and their environments are linked in this way, our [Intelesense] system could have a big impact on the world by monitoring drinking water supplies and producing alerts, thus potentially impacting lots of people and preventing waterborne illness."

The Intelesense system, which is also tracking other major public health concerns like avian influenza, integrates data from a network of widely-deployed sensors with daily public health information, providing governments, public health workers, and researchers with real-time statistics on emerging infectious diseases. This timely information allows for rapid assessment and intervention in the event of an outbreak. Intelesense also has set up shop in Ethiopia, one of the harshest, driest regions of the world and the third most populous nation in Africa. There, the team is developing a network for communicating public health information from 126 remote medical clinics to five corresponding hospitals. The sensors connect all these players with a robust, wireless infrastructure, in an area where there is no reliable cellular or telecommunications network, or even power supplies.

The Intelesense team, seeing the interconnectedness between the native people and the land, realized that it is not just people affecting their environments, but also the environments affecting people. With that understanding, combined with the commitment to harness their abilities for helping people connect with their environments and with each other, the company has steered its technology toward monitoring the interconnectivity between environments and public health.

Thus, the sensors, designed for this deployment, interface with PDA sensors that provide patient information, interact with radio-frequency identification tags on medical and blood-product packages, and also provide real-time, two-way, self-powered video telecommunication. They are part of a large-scale antiretroviral (ARV) study, for which patients receiving treatment are regularly monitored at clinics, and the information is then collected, reviewed, and analyzed at the hospitals. The hospitals can use this system to track supplies of ARV drugs and ensure that sufficient supplies are in areas where the drugs are most needed, as well as conduct virtual training classes. With these classes, doctors at hospitals can telementor clinic staff and spread the medical expertise from hospitals to the remote villages.

Intelesense is currently planning future deployments in other areas of the Pacific, including Palau, Palmyra, Okinawa, and Thailand.

NIH/IDeA Centers to Study Joint Health

RHODE ISLAND

Rhode Island's newest Center of Biomedical Research Excellence (COBRE), launched in the fall of 2007, establishes a multi-disciplinary translational research center of five interrelated projects focused on the mechanisms of cartilage and joint health and disease and the development of a repair strategy. The work encompasses clinical, biological, and engineering research fields. Two projects analyze how long bones are built up during skeletal development. Two other projects examine how joint cartilage degenerates in adult joint diseases. The fifth project studies how to repair and rebuild healthy cartilage joints.

The investigators and mentors are from five departments in the Rhode Island Hospital/Brown Medical School – Orthopaedics, Pediatrics, Emergency Medicine, Medicine, and Bioengineering. The junior investigators include three clinician/scientists and two basic research scientists. The mentors also include both clinician/scientists and basic research scientists, who will supervise junior investigators' research projects, serve as their role models, and mentor them to obtain mainstream federal research project grants. With this enhanced research infrastructure, clinicians will be able to work side by side with basic research scientists, junior investigators with senior investigators, and biologists with bioengineers. This multi-disciplinary approach is absolutely necessary to develop translational strategies for the prevention and treatment of skeletal joint diseases.

Rhode Island's Brown University is home to a second COBRE initiative centered around five integrated projects investigating various aspects of signaling networks involved in the development of cancer. These projects are supported by three cores: an administrative core whose main function is to provide individualized mentoring by senior faculty, and two research cores, one in Mouse Transgenics and the other in Genomics and Proteomics.

The Transgenics Core, directed by Dr. Jan Klysik, supports investigators through the generation of transgenic and mutant mice; its mission is to facilitate access to mouse models of human diseases. Several new lines of mice were created for investigators in the past year, and one of those lines has been delivered for research. In addition, the Transgenics Core has taken on a major rederivation project involving 60 strains of mice brought from Columbia University by a newly hired junior investigator in Neuroscience.

Two other COBRE programs emphasize Perinatal Biology and New Approaches to Tissue Repair. The Perinatal Biology COBRE investigates three areas: heart development, lung development, and the basic science of reproductive biology, with emphasis on placental development and preterm labor. Three new transgenic mouse lines were created as part of these studies. One of these lines is to study preeclampsia, a late-pregnancy condition in 3-5 percent of pregnancies that is a leading cause of maternal and fetal mortality.

Another part of this program is the Kilguss Research Institute located in downtown Providence, RI. The Institute is home to Brown University researchers and their staff who are interested in developmental biology, cancer biology, vaccine development for cervical and breast cancer, and vaccine development for tuberculosis and HIV. Their research reflects "The New Biology," stemming from rapid advances in biomedical research and the new emphasis on cross-disciplinary research and clinical care.

The COBRE for New Approaches to Tissue Repair has developed a center of research excellence in tissue repair by fostering a scientific climate characterized by a strong multidisciplinary approach and the rapid evaluation of potential therapeutic targets based on novel findings. It has become a leading center in the training of junior investigators in the field of tissue repair, and it has mentored junior members who received numerous R01 awards in 2007, the major funding opportunity from the NIH.

At the same time, this center sustains a multi-institutional dimension. While strengthening the research base at its own institution, the multidisciplinary theme of tissue repair links it to other research institutions and scientists within the state, and elsewhere. Ultimately, a major goal is to create a multi-institutional network of scientists with a focus on tissue repair. Underway are two pilot projects with other Rhode Island institutions. In one, an assistant professor from the University of Rhode Island is studying if embryonic mouse stem cells can repair brain toxicity caused by antipsychotic drugs. In the other, an assistant professor from Providence College is studying the epidermal cells that play an important role in wound healing.

Bacterial Change — Benign to Deadly

WEST VIRGINIA

In West Virginia, a Marshall University (MU) researcher has discovered how a relatively benign form of common environmental bacteria becomes pathogenic. The discovery will not only have profound health benefits, but it may also have major economic development implications in biomanufacturing. Dr. Hongwei Yu, an associate professor in the Department of Biochemistry and Microbiology at the university's Joan C. Edwards School of Medicine, published his findings April 30, 2007, in an early edition of the Proceedings of the National Academy of Sciences (PNAS), one of the world's most-cited multidisciplinary scientific serials.

Dr. Yu's groundbreaking research focuses on the signal transduction pathway responsible for conversion of the relatively harmless form of *Pseudomonas aeruginosa* to its pathogenic mucoid phenotype. He has been working on this discovery, which is patent pending, since 1999 when he joined MU's faculty. According to Dr. Yu, the mucoid morphology is due to the overproduction of a large polysaccharide called alginate that forms a thick, slimy "biofilm" around colonies of bacteria, protecting them from the body's immune defense mechanisms. The result can be a life-threatening event when it occurs in the lungs of patients with cystic fibrosis.

Knowledge of the control of mucoidy can lead to earlier diagnosis and more-effective treatment. In addition, Yu's discovery led to a patent application and the development of a new biomanufacturing business for West Virginia. His research has been funded by NASA, National Institutes of Health, U.S. Department of Agriculture, the Cystic Fibrosis Foundation, biotechnology companies, and the West Virginia NASA Space Grant Consortium.

EPSCoR/IDeA

Energy

The EPSCoR/IDeA states play a critical role in the nation's production of fossil energy. Seven of the top ten energy producing states are members of EPSCoR. The research programs conducted within this community are integral to improving the productivity of this immense national resource. The states listed in the charts are engaged in a diverse portfolio of projects that contribute substantially to knowledge about how the U.S. uses and conserves its energy resources.

State Ranking in $1X10^{15}$ Btu* of Fossil Energy Production

Rank	State	EPSCoR Designation	Quadrillion Btu Production
1	Wyoming	EPSCoR	9.505
2	Texas		8.773
3	Alaska	EPSCoR	5.365
4	West Virginia	EPSCoR	4.171
5	Kentucky	EPSCoR	3.042
6	New Mexico	EPSCoR	2.597
7	Colorado		2.163
8	Oklahoma	EPSCoR	2.065
9	Pennsylvania		1.881
10	Louisiana	EPSCoR	1.780

Seven of the top 10 energy producing states are members of EPSCoR

Of the 21 states reporting fossil energy production 17 are EPSCoR states

Net Quadrillion $1X10^{15}$ BTu* Produced and Exported

Rank	State	EPSCoR Designation	Net Quadrillion Btu Exported
1	Wyoming	EPSCoR	9.05
2	Alaska	EPSCoR	4.59
3	West Virginia	EPSCoR	3.35
4	New Mexico	EPSCoR	1.92
5	Kentucky	EPSCoR	1.09
6	Colorado		0.78
7	Montana	EPSCoR	0.60
8	Oklahoma	EPSCoR	0.58
9	Utah		0.25
10	North Dakota	EPSCoR	0.24

Net Quadrillion Btu is the number of Btu's produced minus the number of Btu's consumed by that state

The top five energy exporting states are EPSCoR states as are 8 of the top 10

Both Wyoming and West Virginia export more Btu's to the nation than Saudi Arabia

*Fossil energy in all three forms (coal, gas and petroleum) were converted to the common platform of British thermal unit

Source: Nick Jones, Wyoming Geological Survey, 2007

Production of Hydrogen

MONTANA

EPSCoR investment has led to the development of new catalytic nanoparticles that efficiently produce hydrogen, with the potential for industrial scale-up and an economical energy alternative. To do this, EPSCoR scientists at Montana State University used protein cages from high temperatures in extreme environments found in places like Yellowstone National Park. The potential for industrial use – to address the need for contributing to the creation of hydrogen energy – is being explored.

This work is now supported by grants from the Department of Energy, the National Science Foundation, the Office of Naval Research and the Air Force Research Office.

Petrochemical Replacements: Crop Oils to Fuel

NORTH DAKOTA

By leveraging NSF EPSCoR funding with funds from federal (DOE, DARPA, FAA), state, foundation, and commercial sources, North Dakota researchers have established a comprehensive program to investigate, develop, and commercialize fuels, chemicals, and polymers from crop oils. This initiative became known as SUNRISE (Sustainable Energy Research, Infrastructure and Supporting Education) and was included in the 2005-08 NSF EPSCoR Research RII program. Helped by this sponsorship, SUNRISE developed into a multi-disciplinary, faculty-led group of 20 faculty researchers at both North Dakota research universities with over $6.4 million in research projects, 46 journal articles, 60 technical presentations, and 32 trained students per year.

Led by primary inventor Dr. Wayne Seames, Associate Professor of Chemical Engineering at the University of North Dakota, graduate students working with soybean oil, canola oil, and jatropha oil have generated a variety of fuels – some that meet military and commercial specifications for jet-fuel applications, a biodiesel fuel for cold weather climates where current biodiesel products cannot be easily used, a series of petrochemical replacements, and monomers for biopolymers.

North Dakota is one of the world's major growing regions for oilseed crops, so this work may have a significant impact on the economy of North Dakota as well as on the aviation industry. The new biojet fuel technology is cost-competitive with current biodiesel plants, but both currently require government subsidies to compete with petroleum-based fuels. A primary goal of the SUNRISE program is to develop technologies that will bring production costs down by inventing new fuel products and valuable by-products while reducing upfront oil-extraction costs.

SUNRISE is one of North Dakota's first, faculty-led, student-centered research groups that has the magnitude and resources to compete for major NSF grants. The capabilities in SUNRISE include computational-methods development that supports molecular-level estimates of chemical reaction energies, nanoscale experimental-materials development, detailed experimentation for reaction-mechanism identification and kinetics quantification, lab-scale exploratory studies of potential chemical-based inventions, basic applied research of attractive new technologies, bench-scale optimization and evaluation of new sustainable-energy processes, and pilot-scale validation of commercially-relevant technologies. The first spin-off commercial venture, SUNRISE Renewables, represents a University-commercial partner joint venture that is working to commercialize biofuel and biopolymer technologies developed by the SUNRISE researchers.

EPSCoR/IDeA

Environment and Agriculture

The National Leader in Aquaculture Research

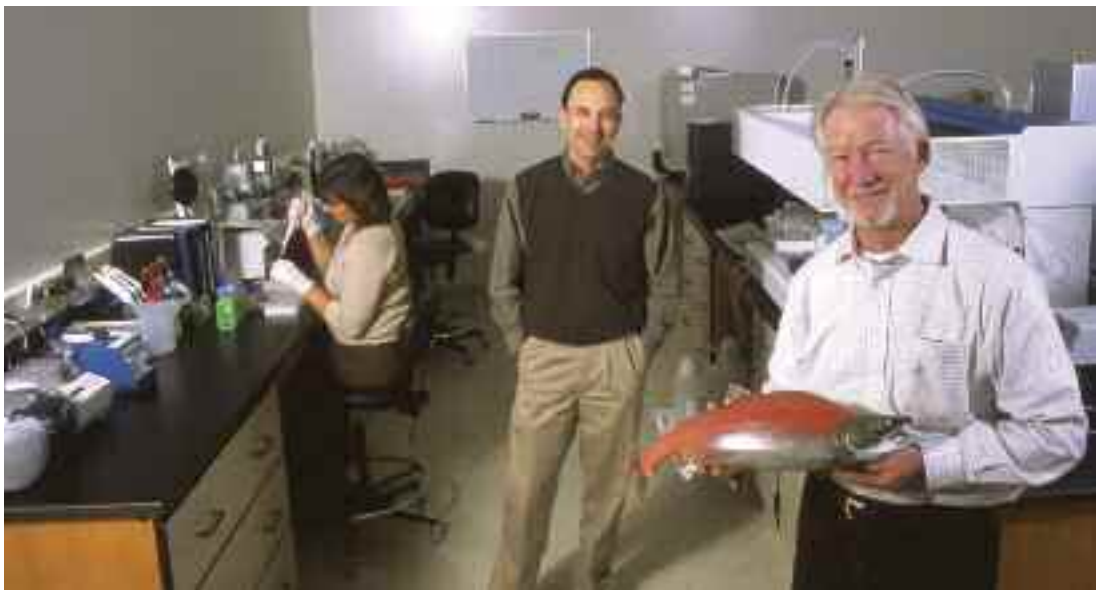
IDAHO

More than 70 percent of rainbow trout farmed in the U.S. are grown in Hagerman, Idaho. And more than 43 percent of all fish consumed in the world in 2005 were farmed fish, making aquaculture the fastest growing animal-production system in the world. NSF EPSCoR's initial investment established the University of Idaho's laboratory research capabilities for salmonid and freshwater species research at Hagerman, and recent NSF EPSCoR Research Infrastructure Improvement investments have helped to expand fish physiology and genomics research as well as water resources research collaborations across Idaho.

The University of Idaho is now the national leader in aquaculture research. According to a 2005 report from Blackwell Science Publications in Oxford, England, the University of Idaho (UI) is the top-ranked American university, and fourth in the world, for number of Institute for Scientific Information-ranked papers published in the Journal of Fish Diseases. Idaho also was ranked the top U.S. university and seventh in the world for publications in all fish-disease journals.

UI recently took steps to bolster its facilities and resources to an even higher level. In September 2006, President Tim White and Idaho Governor James E. Risch dedicated the University's new $3.2 million biotechnology aquaculture laboratory and office complex in Hagerman. The new facility contains state-of-the-art laboratories and equipment and allows scientists to apply advanced biotechnology to fish research, with a focus on rainbow trout.

More than 45 scientists, faculty, and staff are involved in associated laboratory research programs. The program's director was among the first in the nation to win an NSF Partnerships for Innovation award. The program now brings in over $3.5 million per year from federal funds, grants, and contracts. The new facility facilitates partnerships with faculty at the University of Idaho, Moscow campus, and Idaho State University, and allows scientists to explore new areas of discovery — areas that impact people both within Idaho and throughout the U.S. In addition to the Aquaculture Research Institute, the station has collaborative programs with the U.S. Department of Agriculture's Agricultural Research Service, the Columbia River Inter-tribal Fish Commission, the Idaho Department of Fish and Game, and the U.S. Fish and Wildlife Service.



Nobel Peace Prize for Climate Change Report

MONTANA

A Montana scientist has been given worldwide recognition for his contributions to climate change research. Montana forestry professor Steve Running shared the Nobel Peace Prize awarded to Al Gore and the Intergovernmental Panel on Climate Change. Steve Running, one of the nation's foremost experts on climate change, was a lead author of the 2007 United Nations IPCC report that presents strong evidence that "humanity is artificially warming the Earth."

Radioactive Wastes – Cleaning the Nation's Nuclear Dumps

MONTANA and IDAHO

Could microorganisms with an appetite for radioactive waste clean up some of the nation's nuclear dumps? That's the question scientists at Montana State University (MSU) and the Idaho National Laboratory hope to answer. The DOE has identified more than 10,000 individual waste sites associated with the processing of nuclear materials. Spread across 30 states, these sites often contain low-level mixed radioactive wastes. MSU scientists and engineers (funded by DOE EPSCoR) and DOE scientists are using microorganisms to keep radioactive materials from spreading into groundwater. Containment is the first step toward protecting human health and the environment.

These heavy metals, such as chromium, and radionuclides, such as uranium, have a high potential to contaminate clean groundwater near the disposal sites. While there are a few ways to slow or stop this dispersion, they involve pumping the contaminants to the surface or the introduction of toxic chemical external components. By harnessing the microbes that occur naturally there, MSU scientists hope to provide the basis for a less invasive, yet effective, bioremediation strategy. Support for this work continues from the Department of Energy and NSF.

NEW MEXICO

Hydrology, Water Use, and Conservation

As a semi-arid state with low rainfall, New Mexico depends on the study of hydrology to help guide plans for water use and conservation. Research in hydrology supported by New Mexico EPSCoR includes estimation of evapotranspiration in combination with hydrologic modeling to help determine water consumption by natural and invasive vegetation and by the agricultural sector. The results of this research ensure that the state can implement best practices for water use among different constituencies, for control of invasive species, and for determination of water rights. The main objective is to extend and integrate a network of telemetered instruments that provide ground-based measurements of evapotranspiration (ET). Ground-based estimates of ET in different ecosystems (riparian, upland, and agricultural) are provided by flux towers and scintillometers in the Rio Grande corridor.

The hydrology component of NM EPSCoR is dedicated to strengthening the infrastructure for New Mexico's hydrology research. Such infrastructure development will position New Mexico to be a national and world leader in instrumentation and algorithm development for ET estimation and regional hydrologic modeling for semi-arid environments. Currently, infrastructure and equipment funded by NM EPSCoR provide state-of-the-art monitoring of water usage from measurements of evaporation and vegetation transpiration.

Satellite imagery, along with selected ground-based measurements, are being used to develop models for regional-scale estimates of ET. The modeling will yield daily and monthly maps of water usage for agriculture, range, and forest environments. The primary product is high-frequency, high-resolution ET maps for the Rio Grande watershed between Cochiti Reservoir and the Mesilla Valley.

Collaboration and Research in Nanotechnology

Nanoscale science and technology are critical to the advancement of a wide range of applications including electronics and photonics, health care, energy production and conversion, sensors, water purification, and national security. The NM EPSCoR Nanotechnology effort is built upon a solid foundation of collaboration and research. NM EPSCoR is enhancing and leveraging statewide, award-winning education programs that have continually and successfully engaged the state's diverse population.

EPSCoR funding has aided in developing the pool of New Mexico nanoscientists; it provides funding of "start-up" packages for at least five university nanotechnology faculty and allows for release time for faculty in regional universities. In addition, the funding promotes coordination and instrument access and use across New Mexico's universities and colleges.

Understanding Plant Viruses

OKLAHOMA

Research in plant science, particularly plant viruses, is among the many areas of study underway by Oklahoma scientists. Along with programs in nanotechnology, health sciences (where they are engaged in programs to reform undergraduate biology curricula), physics, and defense research, these scientists strive to advance the frontiers of understanding.

In the area of plant biology, they have found evidence of the presence of viruses in about 30 percent of plants sampled at the Oklahoma Tallgrass Prairie Preserve. They recognize the viruses because the sequences of nucleotides resemble known viruses. However, the sequences also show that the Preserve viruses found are clearly different from other known viruses. The result suggests that there are many more species of virus in the world than we currently recognize. The viruses found came from plants that did not have easily noticeable symptoms of infection. If they cause disease, it is probably in another plant.

When most people think of viruses, they think of invisible things that cause disease. The view of this project is that most viruses do not cause disease in their natural hosts. Why the difference? Most viruses known to science are those that capture our attention just because they cause disease. Researchers suspect that natural settings harbor many viruses, mostly unknown to science, whose effects on their host are hard to observe.

Results to date from a NSF EPSCoR-funded project in Oklahoma support this suspicion. Oklahoma scientists have gone to The Nature Conservancy's Tallgrass Prairie Preserve where the land has never been plowed and management is limited to grazing by bison and burning. The Preserve is host to more than 700 species of plants. Samples of most of those have been taken and distributed to several state laboratories to determine whether they have viruses and, if so, what kinds of viruses. A primary tool is the determination of the sequences of nucleotides that make up the genetic material of the viruses.

The work is revealing that plants are complex environments. A plant may be infected with a virus, but also have a fungus in it. The fungus may have a virus. Evidence of the presence of bacteria is also frequent. Dodder is a parasitic plant. Some dodder plants contain fungi which are infected with viruses. The same fungi are found in the plant hosts of the dodder.

The work is important. Viruses in natural settings are likely the source of future emerging diseases. Knowing about them in advance helps prevent or control their emergence. For example, one would not want to plant a new kind of crop in a field where neighboring wild plants sheltered viruses whose effects on the new plant crop would be devastating. Imagine that a major crop suddenly developed a disease that threatened its economic value. A virus pathogen is isolated. Was it put there by an ecoterrorist? Or is it just the natural emergence of a native virus?

To answer these questions, scientists need to know what the "native" viruses are. That is exactly what EPSCoR researchers are accomplishing. Specific viruses will be monitored over time and space at the Preserve, and plants in the vicinity of the plant hosts of the viruses will be catalogued. Such studies may reveal effects of virus infection on the ability of the host plant to compete with other plants, both of the same species and of other species. Investigating such phenomena can lead to natural means to control weeds and other pests in agricultural settings.

Source: Oklahoma EPSCoR Newsletter, spring 2007, by Dr. Ulrich Melcher, Plant Virus Biodiversity & Ecology Project Coordinator

RHODE ISLAND

Climate Change in Temperate Coastal Systems

Rhode Island scientists have made transformative achievements in a number of science and engineering research areas. At the University of Rhode Island, Dr. Robinson Fulweiler, is examining the reversal of the net dinitrogen gas flux in coastal marine sediments. NSF EPSCoR funding provided the necessary instrumentation for Dr. Fulweiler and his colleagues to investigate the effects of climate change on N-cycling in temperate coastal systems. This study may represent the first scientific link between warming and fundamental changes in nutrient cycles. The finding of high rates of nitrogen fixation in heterotrophic marine sediments is unprecedented and has been published in the prestigious journal *Nature*, also available at http://www.nature.com/nature/journal/v448/n7150/full/nature05963.html.

Biodiversity Studies

In a different project, Dr. Brian Wysor of Roger Williams University is investigating the DNA of seaweed. While supported on EPSCoR funds during July 2007, Dr. Wysor worked at the Bocas Research Station of the Smithsonian Tropical Research Institute in Bocas del Toro, Panama, in conjunction with the University of North Carolina-Wilmington, the University of Louisiana-Lafayette, and the Smithsonian Institution-Natural Museum of History.

Numerous new species of seaweed have been found. These will undergo extensive morphological and molecular studies and be formally taxonomically characterized. This work has paved the way for a $725,000, four-year collaborative grant proposal to the Biodiversity Surveys & Inventories Panel at NSF, as well as a $97,459 award from the Rhode Island Research Alliance.

Biocomplexity of Coral Reefs

U.S. VIRGIN ISLANDS

U.S. Virgin Islands investments are building a solid foundation for a center of excellence in marine and environmental science. Initiatives have significantly updated research facilities, equipment and technology at the University of the Virgin Islands (UVI). In addition to new research faculty participating in the Biocomplexity of Caribbean Coral Reefs (BCCR) research projects, an increasing number of UVI teaching faculty are also now participating in the BCCR research thrust. Scientists have augmented research resources at UVI by establishing new collaborations with researchers from other universities, developing stronger partnerships with government agencies, and reaching out to other jurisdictions with mutually complementary programs.

A new graduate program in marine and environmental science will strengthen research and teaching at UVI and produce graduates with skills in research and natural-resource management tailored to local needs. A new graduate program in teaching mathematics for secondary teachers and a new Educational Advisory Board link the university with the local school system in efforts to strengthen K-12 STEM education

The investments made by VI-EPSCoR in its first four years have resulted in significant improvements in the territory's ability to stimulate support and manage competitive research on the Biocomplexity of Caribbean Coral Reefs.

EPSCoR/IDeA

Space

Four-Satellite Mission to Study Earth's Magnetic Shield

NEW HAMPSHIRE

Scientists, engineers, and technicians at the University of New Hampshire's (UNH) Space Science Center (SSC) learned recently that the next phase of a large and complex NASA mission they have been working on for several years will now proceed to the next critical phase. NASA administrator Michael Griffin gave the go-ahead to the space agency's Magnetospheric Multiscale (MMS) mission, meaning that the cast of participants, including those at UNH, can move from the design phase and begin building instruments for the four-satellite mission. UNH has been awarded $61 million from NASA for its role in the mission, which will study little-understood, fundamental processes of Earth's magnetosphere – the comet-shaped magnetic shield that protects the Earth from solar and cosmic radiation.

"This decision propels us forward into the busiest engineering phase of the mission," noted Roy Torbert, director of the Space Science Center within the Institute for the Study of Earth, Oceans, and Space at UNH and the university's principal investigator for the mission. He added, "This is where the engineering and the science come together for this exciting NASA mission."

As part of an international team from 12 institutions, over the next several years UNH scientists, engineers, graduate and undergraduate students will help construct two Electron Drift Instruments (EDI) for each of the four spacecraft. An EDI is designed to measure electric fields and electron drifts using a controlled beam of electrons. In addition, UNH will construct the central electronic controls for all the instruments being built to measure the spectrum of electromagnetic fields around the spacecraft. This "FIELDS" instrument suite will be comprised of six sensors per spacecraft and will be centrally managed by UNH.

The mission is designed to explore the plasma processes that govern the interaction of the Earth's magnetic field with the highly-charged solar wind. Plasma is a highly-ionized gas sometimes described as the fourth state of matter. Plasmas occupy 99 percent of the observable universe, and the physics of plasmas is key to understanding many violent processes throughout the universe. One of those processes is magnetic reconnection, in which magnetic fields reconfigure themselves and release enormous amounts of energy. However, only around the Earth's magnetosphere can direct measurements of reconnection be easily made. Reconnection, a main focus of the MMS mission, is the basic mechanism by which energy from the Sun and solar wind is transferred into the Earth's magnetospheric system.

Reconnection is widely believed to play a crucial role in space and astrophysical phenomena such as magnetospheric substorms and solar flares. Understanding reconnection is necessary to predict "space weather" conditions. For example, a blast of this energy from substorms or solar flares can affect satellites, Earth-based instruments, and power grids; can shower astronauts and aircraft flying over the Earth's poles with deadly radiation; and can light up the sky with aurora.

In 2005, UNH received the largest, single research award in the history of the institution, $38 million from NASA, to build instruments for MMS. The NASA award to UNH has now increased to just over $61 million to, among other aspects of the mission, accommodate post-launch operations that will be carried out by SSC scientists, engineers, and technicians.

The MMS mission is managed by the NASA Goddard Space Flight Center, which will build the four spacecraft and the inter-spacecraft ranging and communication system. Launch for the MMS mission is currently planned for 2014.

Planetary Robots that Self-Heal

VERMONT

At the University of Vermont, Dr. Joshua Bongard's work on robots that can self-heal has been funded by NASA and DOE. He is the recipient of the Massachusetts Institute of Technology *Technology Review's* "TR35 for 2007: The 35 Young Innovators under 35," and he is one of five recipients of the 2007 Microsoft New Faculty Fellowships.

"The research is essential for NASA," said Dr. Bongard, "[because] there is a need for planetary robotic rovers to be able to fix things on their own." Robots on planetary missions must be able to continue their work without human intervention in the event they are damaged and cannot communicate their problem back to Earth. "Our robot is able to detect – without a camera – that something is wrong," Bongard explained, "and teach itself to continue to walk in spite of incurred damage."

Dr. Bongard intends to use robot construction kits, such as Lego Mindstorms, to continue his research at University of Vermont, and will involve undergraduate and graduate students in the process.

Dr. Bongard, together with co-author Rolf Pfeifer at the University of Zurich, also has recently published a popular science book on the nature of intelligence. *How the Body Shapes the Way We Think: A New View of Intelligence* discusses the primary role that the body plays in enabling intelligent behavior, rather than the common view that intelligence arises in the brain. The book covers subjects spanning psychology, engineering, robotics, embedded technology, cyborgs, and the future of adaptive corporations.

Discovery of Exotic Astronomical Event in the Distant Universe

WEST VIRGINIA

Two West Virginia University (WVU) physics professors and an undergraduate student have detected a new astronomical phenomenon. Dr. Duncan Lorimer and Dr. Maura McLaughlin, assistant professors in the university's Department of Physics, and David Narkevic, a senior physics and political science student, discovered a powerful burst of radio waves and subsequently published their findings in the November 2, 2007, issue of *Science*; they also are available at http://www.nrao.edu/pr/2007/brightburst.

"This burst appears to have originated from the distant universe and may have been produced by an exotic event such as the collision of two neutron stars or the death throes of an evaporating black hole," said Dr. Lorimer, who also serves as assistant astronomer at the National Radio Astronomy Observatory in Pocahontas County.

The discovery came as Dr. Narkevic was re-analyzing archived data to find new pulsars that had burst sporadically – as opposed to the usual type of these neutron stars, which pulsate periodically. The team was looking at observations from the Small Magellanic Cloud recorded by the 210-foot Parkes radio telescope in Australia and was surprised to find the burst outside of the cloud in the distant universe. The cloud is a dwarf galaxy located about 200,000 lightyears from the Milky Way.

The discovery involved "a bit of luck" because the survey included observations of the sky surrounding the clouds. The burst of radio waves, considered a significant finding by astronomical standards, lasted less than five milliseconds. The signal was spread out, with higher frequencies arriving at the telescope before the lower frequencies. This effect, called dispersion, is caused by the signal passing through ionized gas in interstellar and intergalactic space. The amount of dispersion in this newly discovered burst indicates that it likely originated about 3 billion light-years from Earth.

"We're actively looking for more of these powerful, short bursts in other archival pulsar surveys and hope to resolve the mystery of their origin," Dr. McLaughlin said. "If we can associate these events with galaxies of known distance, the radio dispersion we measure can be used as a powerful new way to determine the amount of material in intergalactic space."

"We are primarily a program for researching pulsars, but this discovery potentially opens up a whole new area of study here at WVU," Dr. Lorimer noted. "The discovery parallels the story of gamma-ray bursts, which became a new field of astronomy and occupied the research of many scientists for years trying to identify their characteristics. This mysterious occurrence could trigger a new area of cosmic study that we're involved in from the beginning."

The pulsar research program at WVU began in May 2006 when Drs. Lorimer and McLaughlin were jointly appointed by the university and the National Radio Astronomy Observatory in Green Bank, West Virginia, which manages the world's largest fully steerable radio telescope, the 100-meter Robert C. Byrd Green Bank Telescope. The National Radio Astronomy Observatory is a facility of the National Science Foundation.

West Virginia EPSCoR last fall awarded Drs. McLaughlin and Lorimer $490,000 for the creation of a Center for Astrophysics at WVU. The grant was funded through the State of West Virginia's Research Challenge Fund.

EPSCoR/IDeA

Defense and Homeland Security

Real Time Prediction Systems in Ice-Covered Regions

ALASKA

At the University of Alaska, Fairbanks, researchers are investigating the spin-up and spin-down of the upper ocean in response to storms. The observational system will measure surface-to-bottom and density structure, offering a unique opportunity to expand our understanding of how the ocean couples surface mesoscale variability and wave excitation to the underlying ocean on the intermediate-depth continental shelves. This study for the Navy will improve real-time prediction systems for ship navigation and submarine surfacing in seasonally ice-covered regions, such as the Arctic and the Sea of Okhotsk in the Western Pacific, and the Labrador Sea/Gulf of St. Lawrence in the northwestern Atlantic.

The Dream and the Challenge

KENTUCKY

In Kentucky, DEPSCoR has funded 15 research projects since 1993. In a recent project, researchers worked closely with the Navy on aluminum alloys and fabrication techniques critical to shipbuilding. It is anticipated that this research, and testing methods which have also been developed, will be used by the Navy in its ship programs. Department of Defense research has also led to the development of an anti-sniper device now in the prototype stage and under consideration by the Marine Corps.

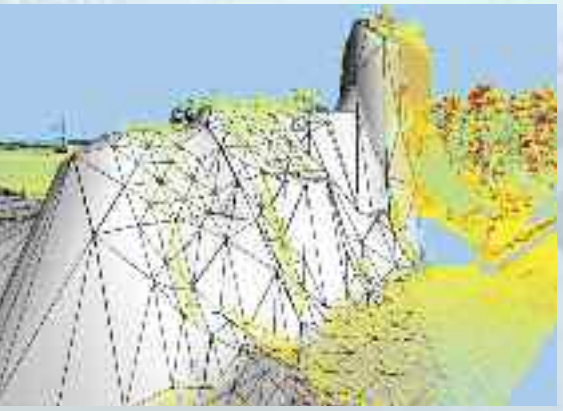
Kentucky is also advancing its science and technology capability in other areas. They are making major advances in health, energy, basic science (particularly computational science and cyberinfrastructure enhancement), with a view toward converting R&D to economic development. The state's S&T advances are not accidental; rather, University of Kentucky (UK) president Lee Todd is driving them systematically. Dr. Todd is no stranger to R&D. He started his career as a UK electrical engineering faculty member, and subsequently played many other roles, including inventor, creator of two companies, and chair of the KY EPSCoR statewide committee from 1989 to 2001. Now as UK President, Dr. Todd has set out an ambitious goal to make UK "one of the nation's top 20 public research universities by the year 2020."

In 2003, he formulated UK's strategic plan, The Dream and the Challenge, to act as a "catalyst to create a new Commonwealth of Kentucky," and do a "better job of reporting to Kentuckians about how their university...is serving them and serving [the] state." This business plan sets forth a "scoreboard," complete with qualitative and quantitative goals for the university to achieve national prominence.

Dr. Todd, who served as interim Project Director of the first EPSCoR grant in 1985, is proud of the fact that the initial EPSCoR proposal was written at his "kitchen table." The lessons from his long-term involvement in EPSCoR continue to drive his vision to transform the university and the state through a more competitive S&T environment.

Extracting Useful Information from Large Data Sets

SOUTH CAROLINA



Industrial societies rely on information buried in an enormous wealth of data that often can carry extremely fine detail. The usefulness of this data rests on the ability to extract (often in real time) the essential embedded information that is pertinent to a given mission. The current state-of-the-art in data processing does not provide the efficient and faithful representations required in most applications. The size and resolution of data sets is growing at a significant rate, making it more difficult to use this data effectively by hindering immediate comprehension and response. Dr. Ronald DeVore and his colleagues at the Industrial Mathematics Institute at the University of South Carolina are developing new processing techniques that can delve into data sets and immediately extract useful data.

The challenge of overcoming problems encountered in the extraction of data from large sets at instantaneous speeds will not be met with incremental advances but will require a fundamentally new understanding. South Carolina scientists are examining the impact of this effort, which will be felt in national security and defense applications, such as autonomous navigation, mission planning and assessment, as well as in several commercial sectors. Using improved algorithms and equations, Dr. DeVore and his team will revolutionize the processing of sensing data for use by autonomous vehicles in real time.

This research is funded by a three-year, $500,000 DEPSCoR grant. Graduate students and undergraduate students are directly involved in the research process, exposing them to state-of-the-art processing techniques and their use in military and civilian applications.

VERMONT

Troop Protection by Decontaminating Chemical Warfare Agents

DEPSCoR-funded work in Vermont involves the development of catalysts that can decompose chemical warfare agents into non-toxic compounds. The University of Vermont has explored methods by which contaminated equipment could be treated in a non-destructive way so that the equipment could be returned to the battle area, which would minimize the downtime experienced because of a chemical attack.

In particular, there are currently very few techniques available to treat the types of sensitive equipment (electronics, objects with complex geometries such as keyboards) on which the modern "warfighter" has come to rely, and the university is specifically studying materials and methods for this application. Finally, protection (prior to an attack) and decontamination (after an attack) are often based on related technologies, and, therefore, the university is also exploring the development of materials that could be incorporated into fabrics and polymers to be used for troop protection. The university has established several connections with industrial partners to discuss commercial development of these materials.

Miniaturized Propulsion Systems for Enhanced Satellite Capabilities

A second DEPSCoR project in Vermont involves the development of a miniaturized propulsion system that will be integrated into next-generation small satellites currently being developed by the Air Force and NASA. These satellites will have masses of less than 20 kilograms and will operate in cluster formations (aka, "formation flying") and therefore be capable of executing mission requirements not easily performed by a single satellite.

The value of nanosats to the Department of Defense is derived from their ability to provide enhanced satellite capabilities for supporting ground-based troops, aircraft, and naval vessels. This support will come primarily in the form of enhanced space-based reconnaissance and communications. Nanosats in particular offer the ability to quickly deploy large numbers of autonomous and effectively "disposable" satellites into space at low cost. Reconnaissance nanosats may be deployed to provide detailed coverage of a particular combat theater for short periods of time, such as six to 12 months.

WEST VIRGINIA

Electric Warship Power Systems

A project headed by West Virginia is working to develop intelligent agents for the reliable operation of electric warship power systems. The objective of this Navy research is to design distributed intelligent control agents for the reliable operation of integrated electronic power systems in modern electric warships. In the event of scheduled load changes or unforeseen disturbances, the power system is expected to operate at a minimum level of performance in areas that could be mission-critical and thus result in saved lives.

This system will consist of at least three layers – a) an electrical network; b) a computer, control, and communication network; and c) a human operator. To make this critical infrastructure operational and efficient, the researchers will have to develop tools and methodologies that combine information technology, and control, communication, and power systems engineering. Thus, an interdisciplinary team of investigators, with expertise in power, control, computer science, and mathematics will work together on these methodologies. The success of this research will have an impact on the reliable operation of electric power systems in an electric warship, as well as on the education of the next generation of power system engineers.

Protection from a Range of Threats

Another West Virginia project is titled, "Fieldable Rapid Bioagent Detection: Advanced Resonant Optical Waveguide and Biolayer Structures for Integrated Biosensing." This research for the Navy will develop direct-detection strategies that are suitable for handheld unit implementation and applicable to a broad spectrum of agents. Such strategies are central to effective protection and response scenarios for a range of threats, from sophisticated biowarfare agents to the simple biocontamination of potable and domestic water supplies.

Integrated optical techniques, based on evanescent-wave interaction, have received considerable attention and study as a means to effectively integrate biolayer surface target binding in direct-detection devices. This research involves a balanced, tightly-coupled interdisciplinary research program for modeling, analysis, and synthesis efforts to establish an analytical and experimental understanding of the interdependence of bio-layer and coupled resonant optical waveguide design, which is necessary for quantifying intrinsic limits of detection, for optimizing realizable extrinsic performance, and for extending the versatility of this important new class of devices.

In addition to these projects, DEPSCoR research in other states includes:

- design of helicopter rotors (Alaska)
- prediction of river currents for Navy operations (Oklahoma)
- effect of DOD personnel exposure to universal military fuel (Oklahoma)
- improved prediction of atmospheric conditions to reduce weather-related accidents (Oklahoma)
- the securing of critical software systems (Vermont and Oklahoma)
- nerve agent detection (Oklahoma)
- enhanced stored-energy density for weapons (Idaho)
- development of small engines that operate on universal military fuel (Idaho)
- improved wireless communication for warfighter systems (South Carolina)
- acquisition and interpretation of sensor data (South Carolina)
- effect of exposure of military personnel to extreme physical and climatic conditions (Montana)
- prevention of laser damage or destruction to aircraft optical guidance systems (Montana)
- increased durability of lightweight composite materials (Montana)
- increased information carried by radar signals (Montana)
- development of Air Force-supported small plastic air-vehicles (Montana)
- ultrafast optical communications and data processing (Vermont)

EPSCoR/IDeA

Commercialization

Kansas Technology Enterprise Corporation (KTEC)

KANSAS

The Kansas EPSCoR statewide committee has had a major impact on science and technology (S&T) infrastructure, policy innovations, and the organizational structure for support of science in the state. Early on, the Kansas EPSCoR committee understood that academic research and development competitiveness, state support for science-based centers, and economic growth are all connected. Kansas EPSCoR was instrumental in establishing the Kansas Technology Enterprise Corporation (KTEC) to create a mechanism to foster competitive S&T from basic research to business and workforce development. KTEC was one of the first comprehensive S&T statewide enterprises.

Modeled after Pennsylvania's Ben Franklin program, KTEC is a private/public partnership. Through support of strategic research and development at Centers of Excellence, through intense hands-on business assistance at incubators across the state, and through direct equity investments in early-stage companies, KTEC serves as an invaluable partner to companies that bring economic growth to Kansas. The Kansas EPSCoR programs are an integral part of KTEC's portfolio.

As a natural extension of its mission, KTEC has played a key role in the statewide Bioscience Initiative. As a sponsor of the Regional Bioscience & Innovation Roadmap process, as a founding member of KansasBio (the trade association for the biosciences) and as a partner with the Kansas Bioscience Authority, KTEC is dedicated to statewide success in the competitive bioscience industry.

KTEC leveraged its expertise and resources to play a key role in the development of the biosciences portions of the Kansas Economic Growth Act (KEGA). Along with many key partners in the Kansas Legislature and Administration, KTEC's efforts to create and pass KEGA have positioned Kansas to become a leader in the field of biosciences. As part of its mission to support technology-oriented economic development in Kansas, KTEC has sponsored the Kansas Bioscience & Innovation Roadmap process this past year. The Roadmap process will provide Kansas a strategic plan as it moves forward to stake its claim in the bioscience industry.

KTEC PIPELINE, an innovative new program, is designed to identify talented and entrepreneurial Kansans, match them with best-in-class training, resources, and mentors, and encourage them to pursue a career as a technology entrepreneur in Kansas. The KTEC PIPELINE adds to KTEC's comprehensive technology program by supporting the most important component to any successful economy – a cadre of innovators that will lead the Kansas economy for generations to come.

Collaboration with Business and Industry

MAINE

The year 2007 marked the tenth anniversary of the Maine Economic Improvement Fund (MEIF), which is widely recognized as one of Maine's most successful public investment initiatives. Over the past 15 years, Maine has experienced a 547-percent increase in academic-based federal research and development (R&D) funding, growing from $9 million to $58 million. This is the largest percentage growth in the country and is due almost entirely to the availability of MEIF funds. Maine's research entities use MEIF funds for cutting-edge R&D projects, by purchasing equipment, renovating facilities, and hiring faculty that make the universities more competitive for federal and private-sector funding. MEIF support also provides the matching funds for research grants.

During the last decade, MEIF funds have combined with funding from NSF EPSCoR to support major projects based at the University of Maine, such as the creation of the Forest Bioproducts Research Initiative (FBRI), the Institute for Molecular Biophysics (IMB), and the Advanced Engineered Wood Composites (AEWC) Center. These types of projects have been enormously successful. The AEWC Center is one of the oldest projects to receive both MEIF funds and NSF EPSCoR funding, and has generated over $42.4 million in income from grants and contracts since its inception.

MEIF-supported EPSCoR projects have enabled new expertise to be brought to the state through faculty hires; have purchased state-of-the-art major equipment and allowed for new R&D capabilities; have provided critical training opportunities for graduate and undergraduate education; and have allowed the state's R&D entities to obtain millions of dollars in federal and private-sector funding and industry contracts.

During the state legislature's first session in early 2007, Maine enacted a new law that established the Maine Innovation Economy Advisory Board (MIEAB) to coordinate the state's research and development activities and to foster collaboration among its higher-education and nonprofit research institutions and members of the business community. The Board consists of 32 members, including the Director of the Office of Innovation and the President of the Maine Technology Institute – both from the Maine Department of Economic and Community Development – and representatives from the industry and research communities in the seven targeted technology sectors.

The MIEAB replaces the Maine Science and Technology Advisory Committee (MSTAC), which had been established by Executive Order in 2003. The membership of the MIEAB is substantially the same as its predecessor committee, but it is now established in statute and will continue from one administration to another.

The MIEAB is required to produce an action plan for Science and Technology every five years, and to produce a progress report yearly on the plan that was approved in 2005. The Board also must provide state and federal policy makers assistance in advancing R&D capacity initiatives in Maine and in developing corresponding funding strategies. The Board also will provide input on economic planning and the commercial application of the State's research and development efforts; facilitate research opportunities that create sustained, inter-institutional, collaborative, multidisciplinary, centers-based research projects; advocate for the state's R&D sector and interests; disseminate information about its work throughout the state; and serve as the EPSCoR steering committee for the state and evaluate proposals made to Maine EPSCoR and related programs.

A Successful Model for Rural States with Strong Statewide Support

WYOMING

In 1996, the University of Wyoming (UW) Research and Economic Development Office launched the Wyoming Small Business Innovation Research (SBIR) Initiative to encourage participation of Wyoming individuals and small businesses in the SBIR and Small Business Technology Transfer (STTR) programs. Initially funded by NSF EPSCoR as a model for other rural states to emulate, the initiative was immediately successful; Wyoming small businesses received more SBIR awards in 1996/1997 than in the previous 13 years combined.

At the same time, Wyoming NSF EPSCoR piloted a Phase 0 SBIR program modeled after Vermont EPSCoR's program. The success of this program resulted in the Wyoming Business Council assuming responsibility, with UW continuing in a management role for the Wyoming Phase 0 Program, which now provides up to 24 awards annually of $5,000 each to assist Wyoming small businesses in the preparation of competitive Phase I SBIR/STTR proposals.

Because of the success of these programs, the state legislature authorized the Wyoming Business Council to continue funding the programs through the Wyoming SBIR/STTR Initiative (WSSI). The WSSI is a program of statewide outreach through conferences, workshops, and one-on-one mentoring in cooperation with personnel from the Wyoming Business Council (WBC), Manufacturing-Works (a manufacturing extension partnership), the Wyoming Small Business Development Centers (WSBDC), the UW Research Products Center (UWRPC), the Wyoming Technology Business Center, the UW Research and Economic Development office, and UW faculty and staff.