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ABSTRACT

This report discusses the social and economic benefits of university research, arguing that if funding for research programs is reduced, short-term savings could impose long-term costs, depriving Americans of scientific breakthroughs, economic growth, and improvements in international competitiveness. It provides over 100 brief summaries of ongoing innovative research projects at selected state universities in research partnerships it described, including expanding knowledge to improve health; creating new tools for fighting disease; helping Americans move into the information age; exploring the building blocks of the universe; restoring, managing, and protecting the environment; assuring the quality and safety of food; building safer buildings, roads and bridges; creating better planes, trains and automobiles; and protecting the energy supply. (JPB)

University Research



TOUCHING

THE LIVES OF ALL

AMERICANS

NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND-GRANT COLL

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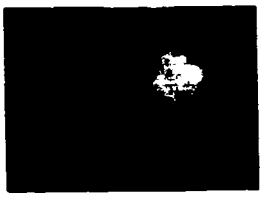
The Benefits of University Research

Since the end of World War II, federally-funded basic and applied research at universities has expanded the base of knowledge, improved Americans' quality of life dramatically and helped make the U.S. an economic superpower. Indeed, research accomplished at institutions of higher education has touched the lives of almost every American.

University research has improved the environment, creating cleaner energy resources and new ways to reduce or eliminate pollution. It has promoted better health, saving lives and raising the quality of life through creating new vaccines, drugs, procedures and medical equipment.

And university research has boosted the economy. Researchers have made discoveries that laid the foundation for industries such as electronics components, plastics and new materials, computers and software, telecommunications equipment and services, pharmaceutical and medical equipment, and aeronautics. These cutting-edge enterprises create millions of jobs and contribute over $600 billion per year to the economy.



A team of scientists at the University of Rhode Island has developed a new biosensor that quickly and effectively detects toxins and contaminants in food.

Basic and applied research at universities have served the public so well because the federal government and higher education joined together in a unique research partnership some fifty years ago. Unfortunately, the university research effort and the benefits it generates could now be at risk.

In the 1990s, the American public and their representatives in Washington have moved strongly to reduce government spending in an effort to balance the federal budget by the early years of the next century. However, unless these proposed spending cuts are made wisely, they could result in relatively modest short-term savings while imposing tremendous long-term costs: depriving Americans of much-needed scientific breakthroughs, slowing economic growth and impairing our international competitiveness. Cutting funds for university research too deeply could also do serious damage to America's great land-grant universities—resources for the nation that have done much of the most important federally-supported research and produced discoveries that have benefited almost every American.

Background

The National Science Foundation defines basic research as "research directed toward increases in knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific application toward processes or products in mind." Applied research is research directed toward gathering the "knowledge or understanding necessary for determining the means by which a recognized and specific need may be met."

Federal spending supports both basic research and applied research. Overall, the federal government accounts for 36 percent of total R&D spending in the United States, while industry supports about 60 percent. In basic research, the federal government has a dominant role, and the bulk of that research is performed at colleges and universities. In FY 1995, the federal government spent $12.4 billion on academic research, some 60 percent of total spending on research at institutions of higher education.

An Investment that Yields Unique Dividends

The last fifty years have proved conclusively that spending on R&D in general and university research in particular is an investment, rather than simply a current expense. That is, federal R&D spending yields dividends and growth. The Council of Scientific Society Presidents cites dozens of independent studies that show that "for each dollar originally invested, federally supported

fundamental scientific research repays the economy approximately 45 cents annually in each succeeding year."

Sixteen of the nation's governors, including the Republican and Democratic chief executives of the ten largest states in the nation, recently wrote to Congress to emphasize the importance of that investment. "We believe that support for university research ought to remain a priority of the federal government," the governors said. "Federally sponsored research translates directly into the knowledge that is now—and will be all the more so in the coming Information Age—the most important form of capital and the primary source of our economic well-being and economic strength."

CEOs of sixteen of America's leading high-tech companies echoed these views in a separate letter to Congress. "History has shown that it is federally sponsored research that provides the truly 'patient' capital needed to carry out basic research and create an environment for the inspired risk-taking that is essential to technological discovery," the executives said.

Is The Research Partnership in Danger?

While federal support for civilian research has been impressive since World War II, it has lagged in the last two decades. Between 1971 and 1991 real growth in U.S. civilian research was less than in five of our primary competitors for world markets, including Germany and Japan. U.S. non-defense R&D is now, in fact, quite low (about 1.9 percent of GDP) compared to our most important economic rivals, Japan (2.8 percent) and Germany (2.4 percent).

Moreover, in recent years, as the pressure to balance the federal budget has increased, some political leaders have called for major cuts in government funding for civilian research. Large cutbacks, combined with lagging federal support over the last two decades, could deny the American people the progress and benefits they have enjoyed over the last five decades.

Large cutbacks also could cripple the future scientific efforts of the U.S. by dissuading young scientists from careers in science and engineering. Budget cuts will mean that projects will be terminated or not renewed, some laboratories may be forced to close, and jobs will be lost. Promising young scientists will have to pursue other careers to earn a living. The impact will be especially hard at universities where, according to the Association of American Universities, some 350,000 jobs are supported by federal R&D grants.

Chemists at Florida State University have synthesized taxol, an anti-tumor drug researchers see as one of the most important weapons developed in the last decade for combating ovarian and certain other cancers.

Universities also provide training and research opportunities for the workforce the U.S. needs to sustain and grow high tech industries—computers, telecommunications, biomedicine, etc.—where the nation is now a world leader.

Finally, large cutbacks could have a devastating effect on a critical aspect of scientific progress—serendipity. Many of the most significant breakthroughs in science were unanticipated, unplanned discoveries that grew out of university research. The technology that led to the AIDS blood test was the serendipitous result of a university researcher's investigations of cancer. Magnetic resonance imaging (MRI), a vital tool of modern medicine, was not the result of a single dedicated research effort. Just after World War II, physicists discovered that hydrogen atoms flip when oriented in a magnetic field. Decades later, basic and applied research in chemistry, integrated circuits, and superconductivity gave birth to MRI. Such unpredictable breakthroughs are possible

only when there is strong and steady support for university R&D.

Some believe that private industry would make up any significant shortfall in R&D funding. However, as the Science Coalition, a broad group founded by public and private universities, has noted, "Basic science projects meet the classic definition of a public good in that they provide benefits to all Americans . . . yet they are too long range and uncertain to expect much private sector support."

Industry funds only about 7 percent of academic scientific R&D, while the government funds some 57 percent. Moreover, the National Science Foundation reports that companies with R&D budgets of $50 million or more are planning to decrease spending by 3.5 percent overall.

Powerful Arguments for Continued Support

In sum, if university research is to continue to improve the environment, promote better health, and boost the economy, the research partnership between higher education and the federal government must survive and be strengthened. The following pages present only a small sample of some of the important work that is ongoing at universities, thanks to the research partnership. This work includes:

- Expanding knowledge to improve health;
- Creating new tools for fighting disease;
- Helping Americans move into the information age;
- Exploring the building blocks of the universe;
- Restoring, managing, and protecting the environment;
- Assuring the quality and safety of food;
- Building safer buildings roads and bridges;
- Creating better planes, trains, and automobiles; and
- Protecting the energy supply.

Each of these examples contributes to the well-being of the nation and adds another powerful argument for continued federal support for university research.

Researchers at the University of Kentucky have developed a new process that will recycle nearly 100 percent of waste plastic into oil and convert tires into oil and valuable carbon black.

1. Expanding Knowledge to Improve Health

Medical advances not only save lives and improve the quality of life—they reduce the costs of treating health-related problems. University research has always been a major source of breakthroughs in medical knowledge. Today, as the debate on the future of the nation's health-care system continues, NASULGC universities are deeply involved in a myriad of research efforts to improve health and save lives.

■ Colorado State University

Diabetic neuropathy is a condition that affects 10 percent of the 14 million Americans who have diabetes. The condition is characterized by numbness and pain in the hands, feet, and legs and it can set off a cascade of other serious complications including impotence, urinary and bowel dysfunction, dizziness and gangrene (which resulted in 50,000 amputations in the U.S. last year). Previously thought to be a result of high levels of blood sugar, researchers at the university discovered that the condition is linked to lowered levels of insulin-like growth factors (IGFs). The discovery opens the door to exploring treatments that involve a combination of diet, exercise, control of high levels of blood sugar with medicine and IGF replacement.

University audiologists have also identified one cause of Meniere's disease to be a small hole in the inner ear that leaks fluid. By closing the hole with a simple procedure, surgeons may be able to eliminate the vertigo and ringing sensation characteristic of the disease.

■ Kent State University

Behavioral scientists at the university have developed effective, non-medical ways to help curb the AIDS epidemic. Using a program that builds self-esteem and assertiveness, researchers from the university's Applied Psychology Center work with young, inner-city heterosexual women in an effort to encourage them to adopt safer sex behaviors.

■ Massachusetts Institute of Technology (MIT)

Deeply involved in biotechnology projects, scientists at MIT have done pioneering work in molecular biology and genetic engineering (the basis of biotechnology) in addition to research in closely related fields, such as immunology, virology and genetics. Five faculty members of the biology department have won Nobel Prizes for their work in this area. In concert with other university researchers, they have made major contributions to the elucidation of the genetic code; were instrumental in the development of recombinant DNA technology, the basis of genetic engineering; and have fundamentally contributed to the development of gene therapy, the second generation of the biotechnology revolution with great potential for treating diseases at their root or genetic level.

In addition, this work has led to key contributions in the identification of the genes responsible for Huntington's Disease and Lou Gehrig's disease, has helped identify the first tumor suppresser gene (a vital step in the battle against cancer), has shed new light on the genetic basis of cancer, and has created novel vaccine strategies for cancer and AIDs.

■ Penn State University

Researchers have developed a faster and cheaper technique for discovering antibodies that could be used as artificial enzymes to replace missing enzymes in conditions such as sudden infant death syndrome (SIDS), orotic aciduria, Parkinson's disease, and combined immuno-deficiency syndrome (SCIDS). Other research at the university has revealed, for the first time, how a protein called kinesin acts as a biological motor to power the transportation of chemicals within nerve cells. This information is valuable for research on potential therapies for conditions such as Parkinson's and Lou Gehrig's diseases that are caused by the degeneration of nerve cells.

■ Texas Tech University Health Sciences Center

Researchers at the health sciences center have identified the protein responsible for intracellular conversion of cholesterol to steroid hormones. The protein—Steroidogenic Acute Regulatory protein—has been sought by researchers for more than three decades.

■ University of California, Los Angeles

Scientists have for the first time identified the cause and a preventative therapy for insulin-dependent diabetes

mellitus in laboratory mice. The findings have important implications for understanding the cause of the disease in humans and for developing a cure.

■ University of Georgia

In a development that could have implications in the fight against AIDS, researchers at the university have reported that the element selenium may play a key role in the biochemistry of HIV. By analyzing the genetic code of HIV, researchers have also discovered as many as four new potential genes in HIV.

■ University of Hawaii

University of Hawaii researchers have discovered that inherited changes that confer resistance to Bacillus thuringiensis (BT) toxins in insects may also reduce their ability to mate and survive when BT is not present. Understanding the evolutionary principles at work in the development and reversal of resistance to pesticides in insects may provide clues for medical scientists combating the growing resistance of many bacteria to antibiotics.

■ University of Indiana

Researchers at the university have discovered a way to clone a protein shown to be highly effective in delivering new genetic information into blood cells. This gene transfer technology brings researchers a step closer to the development of genetic therapies for inherited blood disorders, AIDS, and cancer.

■ University of Minnesota

Several studies at the university over the last decade have led to major medical breakthroughs in the treatment of diabetes, cancer and Lyme disease.

Results of an eight-year study on the devastating complications of diabetes mellitus determined that the rate and severity of complications could be reduced if patients could manage their diabetes so that blood sugars could be contained within the normal or close to normal limits. The results of the study have put to rest a controversy about whether or not a patient can do anything to make a difference once he/she has diabetes.

In the area of cancer research, the university's work on the treatment of ovarian cancer has led to the development of taxol as the first line drug treatment for ovarian cancer. University doctors began using taxol in combination with cisplatin—which had been the routine drug of choice for more than a dozen years. Results of the study using taxol indicated that it helped extend—in many cases doubling—the patient's survival time.

■ University of Nebraska-Lincoln

Researchers at the university have discovered a protein factor that appears to control and regulate the initiation of protein synthesis in an organism, a key biological process. The new factor, labeled P67, must be present in order for a previously-known protein complex—eIF2—to begin the process of building a specific protein. This discovery is critically important in providing vital information on the protein synthesis process and might prove to be an important biological means of combating viral infections in animal cells.

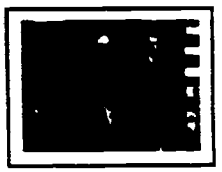
■ University of New Mexico

Researchers at the university's Cancer Research and Treatment Center have shown that repeated and unusually high doses of chemotherapy can be given to cancer patients more safely thanks to a drug call Granulocyte Macrophage Colony Stimulating Factor (GM-CSF). GM-CSF is one of the circulating chemical "messengers" called cytokines that regulate production of white blood cells. This work tests the hypotheses that white blood cells depleted by intensive chemotherapy can recover without bone marrow transplant and that GM-CSF can reduce the duration of low white blood cell counts and the need for prolonged hospitalization. Side effects of GM-CSF are also minimal.

■ University of North Dakota

Basic research by biochemistry researchers at the university has led to characterization of glycogen storage disease. The disease renders the body unable to release glucose from the liver and kidney because of inborn errors of metabolism. This research contributes to the basic scientific understanding of blood sugar in the body.

The Biology Department conducts basic research in the areas of genetics, plant and animal development, physiology, behavior, ecology and wildlife biology. These studies increase the understanding of basic biological principles from genetic control of



cellular and organismal function to the interrelationship of mankind with the biosphere.

■ University of Puerto Rico, Medical Sciences Campus

Studies at the university on the heart's renin-angiotensin system have yielded important implications for the management and treatment of pathophysiological conditions such as heart arrhythmias. The studies, which focused on the synthesis of Angiotensin II inside rat cardiac myocites, indicated that the synthesis process plays an important role in the propagation of electrical impulses in the heart.

■ Texas A&M University

A study of gene manipulation in plants at the university may lead to the development of edible vaccines. Currently, researchers are using potato plants to develop vaccines against common bacterial and viral diarrhea. Other work involves bananas that express a gene that can give immunity to hepatitis B. Edible vaccines could become an affordable way for the developing world to attack diarrheal diseases and hepatitis which both kill millions of children each year.

■ University of Tennessee

Several basic scientific and medical breakthroughs have been achieved over the past several years at the university's College of Veterinary Medicine. In one study, scientists developed a research model in mice that allows for vaccine production against herpes simplex virus (HSV) in humans. That virus causes genital and facial ulcers in humans. Other researchers characterized an exact dog model of a human disease—primary ciliary dyskinesia—which is the second most frequently inherited respiratory disease in humans. Similarly, researchers established a perfect animal model allowing research on mucopolysaccharidosis—a devastating heritable disease of children with 100 percent fatality. Currently the model is being used to investigate the possibility of gene therapy for this disease in children.

"If basic research withers, America won't produce the breakthroughs and innovations that have helped make it an economic powerhouse and a strong global competitor. Washington must balance the budget and restore fiscal responsibility. But it must not be done in a way that forfeits the nation's future by stripping away the bedrock investments on which new generations will build and prosper. Science is one of those."

—*Chicago Tribune* editorial, August, 1995

■ University of Virginia

Researchers at the university developed the ADENOCARD, which administers adenosine (a naturally occurring substance) in IV form to patients with supra-ventricular tachycardia, restoring the heart within minutes to normal sinus rhythm. Other work at the university led to the development of mass spectrometry to identify proteins in blood and semen up to 10 years after it has been deposited. This method is used worldwide in forensic medicine to aid in criminal investigations.

■ University of Washington

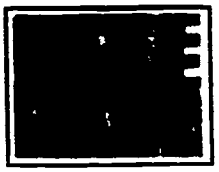
Bone marrow grafting techniques developed by one of the university's Nobel Prize recipients, E. Donnall Thomas, saved thousands of lives of leukemia and radiation exposure patients. The university's biochemists Edmond Fischer and Edwin Krebs were awarded the Nobel Prize for their work on the function of the protein phosphorylation as a regulatory mechanism.

■ University of Wisconsin-Madison

Basic research on vitamin D, how it is converted to its active form, and how the active form works has led to an important new development in the treatment of psoriasis by researchers at the university. Scientists at the university have synthesized analogs of the active vitamin D hormone that suppress growth and cause differentiation of keratinocytes of skin without elevating serum calcium. These compounds can be applied safely to skin of patients suffering from psoriasis, providing a new and effective treatment of this disease.

■ Wichita State University

An audiologist at the university found that many people who work-out in health clubs are exposed to damaging levels of noise which may result in permanent hearing loss. The study conducted indicated that 90 percent of the health clubs and spas monitored consistently played music above OSHA-condoned levels. Other studies over the past several years by health scientists at the university have led to determining what exercises are appropriate for people with mental and physical handicaps and how those exercises can aid in their rehabilitation.

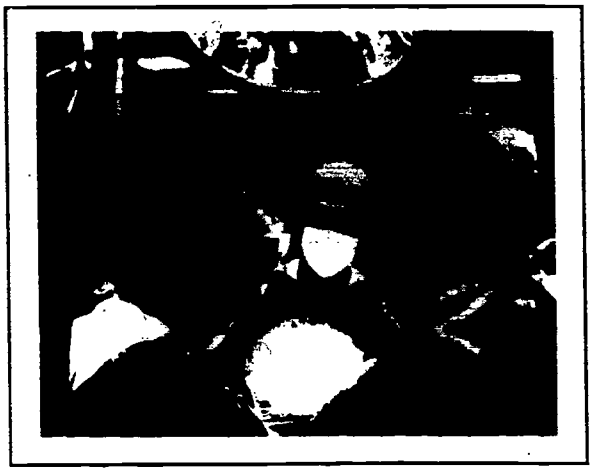


■ Wright State University

Deemed a "national treasure" by the National Institutes of Health (NIH), the university's Fels Longitudinal Study, started in 1929, is the world's largest and longest running study on human growth, body composition, and risk factors for heart disease. Fels research participants are enrolled in the study at birth, and their stature, weight, and other body characteristics are measured every six months or yearly throughout childhood and continue on a regular basis throughout adulthood. The longitudinal continuity of those body measurements provides a unique opportunity in the field of cardiovascular research.

For example, Wright State researchers have shown that high blood pressure and high cholesterol levels begin to "track" from childhood into adulthood. Using Fels data, scientists have been able to determine that children with high blood pressure or high cholesterol are more likely to have high values for either factor in adulthood.

2. New Tools for Fighting Disease



As doctors and other medical researchers battle threats to health, university research is providing new medical equipment, drugs, and techniques of treatment that are helping people live better and longer. NASULGC universities are now as always on the leading edge of that research, providing health care professionals with the tools they need.

■ Florida State University

In the quest to combat cancer, chemists at the university have synthesized taxol, an anti-tumor drug. Researchers see taxol as one of the most important weapons developed in the last decade for combating ovarian and certain other cancers.

■ Kent State University

Special education faculty members at the university have developed an electronic sensing device that gives people with physical disabilities more control over daily tasks. Similar to a light switch that turns lamps on and off, this device, when interfaced with other technology, allows a person with disabilities to move a wheelchair, adjust the TV volume and even use a computer.

■ Michigan State University

Nuclear physicists working at the university's National Superconducting Cyclotron Laboratory developed the world's first superconducting medical cyclotron. A major advancement in the fight against cancer, the cyclotron rotates around a patient using neutrons to kill cancer cells. It is currently housed at Detroit's Harper Hospital. In other medical research, university scientists have isolated a gene that regulates major growth hormones in plants. The discovery opens the door to eventually being able to regulate the size and shape of plants.

■ Oakland University

Pioneers in bioelectronics, researchers at the university have developed a microscope electrode that can detect trace concentrations of elements or molecules within a single biological cell. A very promising application for the electrode may be in finding the presence of nitric oxide; scientists have only recently discovered that nitric oxide stops cancer cells from dividing and transmits signals between brain cells. At present, the microscope electrode is the only direct method for detection of nitric oxide in a cell.

■ Purdue University

To meet patient needs for bladder repair, cardiovascular replacement and orthopedic augmentation, researchers have developed a tissue engineering technology called "SIS" or small intestinal submucosa. SIS is derived from modified swine intestine and will be used to construct tissue replacement products.

■ San Francisco State University

Research at the university has led to the design of low-cost wheelchairs which can be manufactured in over 20 underdeveloped countries around the world. The chairs are built using materials easily found in each country and provide mobility both indoors and in rugged outdoor terrain. In addition, the university is establishing a worldwide networking movement that shares information and ideas in designing of wheelchairs.

■ State University of New York at Stony Brook

A chemist at the State University of New York at Stony Brook, in collaboration with physicists at Princeton University, discovered a new approach to Magnetic Resonance Imaging (MRI), called "hyperpolarized gas imaging." The new method polarizes trace gases patients inhale. The gases can then be detected in the lungs, brain and heart. Traditional MRI detects polarized protons in the patient's body. The new approach allows researchers for the first time to map lung functioning and to determine what part of the lung is working and what part is not. This is particularly helpful for treating conditions such as emphysema. Other promising applications include imaging the blood vessels of the heart, which is important for diagnosing various heart conditions, and imaging brain function by tracing how various stimuli affect the flow of the blood in the brain. In addition, the new technique does not require the manufacture of new equipment. Instead, existing MRI machines (of which there are 3,000 in the United States and 6,000 worldwide) can be retrofitted.

■ State University of New York at Stony Brook

Scientists have discovered that tetracycline and doxycycline (common anti-bacterial medications) have non anti-bacterial properties that can prevent periodontal disease by interfering with the production of collagen ASE (a collagen destroying enzyme). Given these characteristics, other potential applications for these common drugs include treatments for tumor metastases, osteo-arthritis, and diabetic nephropathy.

■ Temple University

Researchers at the university have invented a method to release drugs into the body evenly over a 24-hour period. The invention assures that patients will receive the correct dosage of medication throughout the course of a day.

■ University of Buffalo, SUNY

Vasodilators are a class of nitrate-based drugs, one of the most common of which is nitroglycerin, that are used in the treatment of congestive heart disease and other cardiovascular disorders. Researchers at the university have developed a new class of vasodilators. In experiments, the new drugs have produced more prolonged protective effects without common side effects—such as headaches—associated with currently used nitrates.

■ University of Florida

Glaucoma is one of the leading causes of blindness in the United States. Pharmacological research at the university has led to the development of Trusopt, a new form of eye drops aimed at improving control of glaucoma. The drug, generically known as dorzolamide, has fewer side effects than currently available glaucoma medicines.

"Our nation has benefited enormously from the curiosity-driven research emanating from its research universities . . . . [A]re we setting a course that will lead to the demise of our nation as the preeminent source of innovation and creativity and, consequently, to its demotion from status as the world's economic superpower? I worry that the answer could be yes."

—William E. Kirwan, President, University of Maryland at College Park

■ University of Houston

Research at the university's School of Pharmacy is leading to a cure for congestive heart failure (CHF) through gene and/or drug therapy and researchers have described an entirely new class of pharmaceuticals that may be able to control previously resistant diseases. Other work at the university's Center for Superconductivity has led to a non-invasive ultra sensitive magnetic detection device which can monitor brain and heart activity even in a fetus in utero.

■ University of Illinois at Urbana-Champaign

A cheaper, better way to coat artificial bones and joints to be implanted in the human body has been developed by a researcher at the university. The new coating should aid the immediate fixation of a prosthesis, so patients won't have to be immobilized for a long time. This innovation will not only help hospitals save on costs, but will contribute to a quicker recovery because immobilization is detrimental to health.

■ University of Illinois at Chicago

The university has played a pivotal role in a successful trial of a breakthrough drug treatment designed to reduce the often-severe pain of sickle cell disease. Last January the National Heart, Lung and Blood Institute issued a clinical alert informing physicians and other health professionals that daily doses of the drug hydroxyurea have been found to reduce the frequency of painful episodes or crises of sickle cell. Fifty seven percent of the study's 300 patients were treated at the university's sickle cell clinic (the largest number of the study's 21 clinical trial sites).

■ University of Iowa

Scientists have long regarded DNA primarily as a carrier of genetic information. However, a research team at the university has discovered that a specific DNA component in bacteria and viruses—called CpG DNA—activates the body's immune system. This finding could have implications for improving the effectiveness of vaccines and other disease treatments.

■ University of Kansas Medical Center

The development of Strontium-89 (Metastron), a radioactive drug that treats the pain resulting from bone cancer, was spearheaded by doctors at the university's medical center. Other work at the center has led to the discovery of the life cycle of the parasite Toxoplasma gondii. This parasite causes toxoplasmosis, a disease leading to birth

defects in babies and illness or death in AIDS patients.

Medical center researchers developed a virus, KU SHIV, the first animal model for HIV-1 disease (the deadliest of the two HIVs and the most common in the United States and Europe.) Other researchers discovered two molecules of the basement membrane, which explain much of the pathology of diseases affecting the kidneys, including Goodpasture syndrome, Alport syndrome and diabetes.

■ University of Memphis

Researchers in biomedical engineering at the university have developed a computer model that allows researchers to map the flow of electric current during defibrillation. The study, for the first time, permits physicians to determine the amount of electric current needed, depending on the placement of the defribillator paddles, to make the most efficient use of the device without causing additional tissue damage.

■ University of Michigan

Basic research by epidemiologists at the university has culminated in the development of a strain of influenza virus that can be used as a flu vaccine. The new vaccine is a "cold attenuated" virus that is administered as nose drops. It grows only at the relatively low temperatures found in nasal passages where it triggers immunity without spreading the flu to warmer lung areas. The vaccine can be easily updated each year to match new influenza strains.

■ University of Missouri

Researchers at the university have developed a new technology for cancer radiation treatments. Glass microspheres one-third the diameter of a human hair carry radiation directly to a cancer tumor after being injected through a catheter into the artery that supplies blood to the liver. Radiation is thus delivered and "time released" to the tumor in four to five times the strength otherwise afforded.

■ University of Missouri-Rolla

Original research at the university on a special class of antibiotics has led to the invention of chirobiotic columns—a way to remove unwanted side effects from medicines, food additives, and pesticides. The new technique uses the antibiotic vancomycin and other related macrocyclic glycopeptide compounds. The compounds are bonded to silica gel (a white powder that resembles very fine sand) and packed under high pressure into a steel column. Compounds are then pumped through the column, which separates the desired drug or chemical from its mirror-image or "chiral impurities." The process produces substances that are purer and have fewer side effects.

■ University of North Carolina at Charlotte

A multiple function, portable heart monitor was developed by researchers at the university. The invention discloses a method of monitoring multiple aspects of a patient's cardiac condition. It is portable, microprocessor-based and can be programmed to select for storage (in RAM) anomalous heartbeat waveforms while rejecting normal waveforms. In addition, the cardiac monitor gives real-time warnings of erratic heartbeat waveforms and stores them for future analysis. The cardiac monitor can also detect and energize an alarm if the patient's heartbeat skips a predetermined number of beats.

■ University of Pittsburgh

Researchers at the university have developed new techniques that allow cryosurgery to be performed on the liver, the prostate and other previously inoperable areas of the body. These techniques have resulted in a dramatic increase in the number of cryosurgeries.

■ University of South Dakota

Of the approximately 50,000 people in the United States who have cornea transplants each year, at least 5,000 have the transplants rejected by their immune system. Researchers at the university have developed a new artificial cornea that shows remarkable promise for successfully reducing the current rejection rate.

■ University of South Florida

A trephine is a surgical tool used to shape a cornea obtained from a donor eye for eventual transplantation in a patient. Researchers have invented a new trephine—the Tampa Trephine—that minimizes the time for surgery,

healing and any subsequent potential astigmatism problems. The new trephine cuts the cornea with six precisely cut tabs that are inserted in incisions in the patient's eye. Current cornea transplantation typically requires as many as 32 sutures. The use of so many sutures requires long operation times, extended healing time and introduces serious astigmatism that may never be totally corrected.

■ West Virginia University

Although human gene therapy is becoming more and more practical, concerns about safety of the procedure to the patient and the general public remain. One concern is spread of retroviral vector carrying a virus that can replicate itself. To address this issue, researchers at the university have developed a series of novel retroviral vectors. The new vectors destroy their own capacity to replicate.

3. Into the Information Age

Computers have become a fact of life, revolutionizing business, home and entertainment and ushering us into the information age. NASULGC universities play a central role in this revolution. Through their research efforts to develop new technologies and applications, they are moving us further and further along the information superhighway.

■ Cleveland State University

Researchers at the university working on The Technology Enhanced Accent Modification (TEAM) Project have developed a tutoring program which provides audio and visual feedback via computer to international teaching assistants trying to improve their English-speaking skills. Users are able to adjust their pitch, intensity and cadence to the program and most have gone on to pass a speech proficiency test required by the state of Ohio.

■ Kent State University

Looking toward the future, researchers at the university's Glenn H. Brown Liquid Crystal Institute are developing materials and technology that is likely to be an integral part of the interactive, electronic newspapers and books of the 21st century. At the core of this work is the development of a reflective, flat-panel display that will make screen displays for laptops, hand-held computers, and other portable devices smaller, lighter, and more energy efficient and will produce high-contrast images that can remain on a screen longer.

■ University of Central Florida

Great strides in the design and performance of computers has been made possible by the development and use of advanced materials. For example, the quest for smaller, faster computer components resulted in the use of silicon, making possible a computer on a chip. Following in this tradition, researchers at the University of Central Florida are developing new organic photonic materials for use in computer hardware. Characteristics of the new materials, such as low heat conductivity, mean they could have a multitude of applications in the area of high-speed computing, particularly for the "on/off ramps" for the information superhighway.

■ University of Massachusetts-Amherst

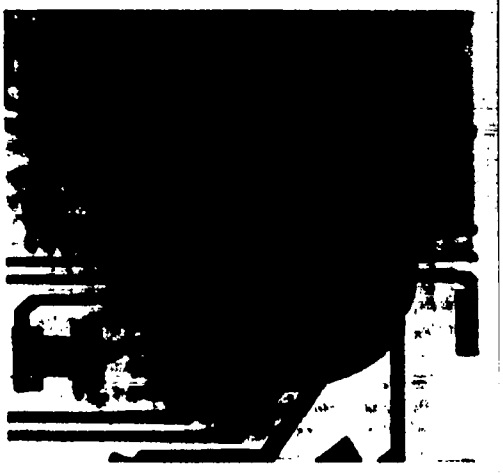
Computer scientists at the university developed a revolutionary new tool for the information age, a search engine called INQUERY that quickly retrieves information from very large databases—and requires no specialized knowledge or vocabulary on the part of the user. INQUERY represents a quantum leap forward in the use of artificial intelligence software for retrieving key information from massive amounts of data. Current applications of INQUERY directly benefit anyone who accesses the on-line resources of the Library of Congress, Congress, and many other organizations currently using this powerful information tool. Future uses of INQUERY may include physicians and scientists needing access to worldwide research in everything from cancer to Ebola fever.

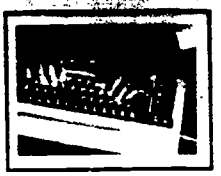
■ University of Mississippi

Experimental and theoretical work at the university's Center for Wireless Communications has supported the development and implementation of new wireless personal communications equipment and services. Of particular note are the contributions to the realization of a nationwide two-way messaging system.

■ Texas A&M University

Theoretical mathematics research in boundary-spline-wavelet analysis at the university has lead to the development of a new technology that can compress still images up to 300 times, while maintaining excellent clarity and resolution. The new technology, called HARC-C, can reduce a file size from 2.4 Mb to 8 kb with little or no specialized hardware. Movies compressed with the





software can even be viewed on personal computers. HARC-C could have applications in medicine, entertainment, education and science.

Other work at the university has led to the development of a computational infrastructure that provides tools for basic scientific research and a medium for information exchange among researchers. The Keck Center for Genome "Informatics," as it has been dubbed, facilitates both the study of genome organization and the access to information over computer networks. Informatics is revolutionizing the way basic research results are managed and is making these results easier to access.

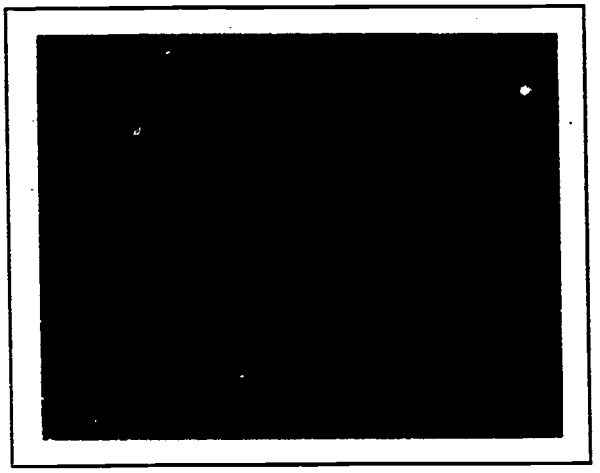
"One of the more compelling arguments for eliminating the deficit is that in continuing to pile up the national debt, we are, in effect, asking future generations to pay for our current consumption and lack of political will. Ironically, however, we compound the harm to future generations by treating today's academic research as just a current expense—as opposed to the investment it actually is."

—Richard S. Nicholson, executive officer of the American Association for the Advancement of Science

■ University of Tennessee

Researchers at the UT Space Institute have developed a method to solve two-dimensional acoustic field equations 100 times faster than currently possible and three-dimensional equations 2000 times as fast as older methods.

4. The Building Blocks of the Universe



Universities have always taken the lead in exploring the fundamental materials and forces that make up the universe. NASULGC universities are engaged in important basic research on the building blocks of the universe, research that lays the basis for breakthroughs in many fields.

■ San Francisco State University

After confirming the discovery of the first planet outside our solar system, university astronomers went on to discover two new planets outside our solar system. The two new planets—the second and third ever—are both at temperatures that mean they could harbor water in liquid form, the basic building block for life. These discoveries prove that planets are not rare in our galaxy, and will also begin answering important questions regarding other planetary systems. Astronomer Geoff Marcy and Paul Butler expect to announce the discovery of more planets in the coming years, now that they have perfected a unique systems for detecting tiny wobbles in distant stars that indicate the presence of a planet.

■ University of California at Irvine

Stanford University's Martin Perl and the University of California at Irvine's Frederick Reines were this year's recipients of the Nobel Prize in Physics for pioneering experimental contributions that revealed "two of natures most remarkable subatomic particles." Perl discovered a massive entity called the tau leptron; Reines discovered the neutrino. Both findings were essential to developing the present standard model of fundamental particles that describe all interactions of subatomic constituents.

University of California at Irvine's F. Sherwood Rowland received the 1995 Nobel Prize in Chemistry for atmospheric studies which led to an understanding of how the ozone layer forms and decomposes, and contributing "to our salvation from a global environmental problem that could have catastrophic consequences." Rowland shared the prize with former UCI colleague Mario Molina, who currently is at the Massachusetts Institute of Technology; and Paul Crutzen, a professor at Max-Planck Institute for Chemistry in Germany and adjunct professor at Scripps Institution of Oceanography at the University of California at San Diego.

■ University of New Hampshire

The university is the U.S. leader of the Compton Telescope (COMPTEL) program on NASA's Compton Gamma Ray Observatory (GRO). COMPTEL is revealing new information about the most energetic processes in the universe, including probing "gamma ray bursts" one of modern astronomy's greatest mysteries.

■ University of Pittsburgh

A team of researchers at the university is studying the Wolf-Rayet stars to discover where certain elements are formed. To conduct their research the team employs ultraviolet astronomy in the Astro2 observatory which is installed on the space shuttle Endeavor.

In other work, physicists at the university formed one of two research teams that helped to find the last undiscovered basic particle—the top quark.

and Protecting the Environment

In the more than twenty years since the nation first began to focus on threats to the environment, university research has contributed to the very real progress that has been made in fighting pollution and other threats to the earth's biosphere. But some threats have persisted or become more complex, and new ones have emerged. Many NASULGC universities are taking up the challenge by becoming deeply involved in research to restore, manage, and protect the global environment.

■ Auburn University

Researchers at the university are working on ways to convert waste plastics and coal into viable fuels. Once perfected, this technology will reduce the amount of plastics buried in landfills and cut U.S. dependency on foreign oil.

■ Cornell University

University scientists have made critical advances in understanding how chemical pheromones are used by insect pests. This work has led to developing pest control approaches that have reduced dependency on pesticides worldwide .

■ Indiana University

Scientists at the university have developed a non-toxic and non-polluting mouse repellent. The repellent uses pheromones that dominant male mice use to mark their territory and will safely keep mice away from homes, restaurants, grocery stores, grain-storage areas, and food processing plants.

■ Michigan Technological University

Reducing chemical and energy requirements in manufacturing processes means less pollution to the overall environment. For the past five years, researchers at the university's Institute of Wood Research have reduced pollution through their work on genetic engineering of pulpwood species. To date, they have cloned gene-encoding enzymes for synthesizing a wood polymer, lignin, which needs to be removed during pulping in order to efficiently extract the cellulose for pulp and paper making. Through genetic engineering, researchers will be able to manipulate the expression of lignin genes to regulate its chemical reactivity, resulting in a reduction of the need to use chemicals during the extraction process.

■ North Carolina State University

The use of chlorine as a bleaching agent in the manufacture of paper produces harmful dioxin emissions. Basic research on the pulp bleaching process intrinsic to the manufacture of paper at the university has helped the U.S. paper industry substitute chlorine dioxide for elemental chlorine as a bleaching agent. The result has been the reduction of dioxin emissions by the entire U.S. paper industry, from several pounds per year to approximately four ounces.

■ Ohio State University

Studies at the university of ice cores retrieved from ice caps and glaciers in Asia, South America, and Antarctica have shown that these tropical ice fields are the best indicators of changes in global weather patterns. This research has provided not only historical data on the world's ancient climates but also indications of potential future climate changes.

■ Oklahoma State University

Data from basic studies done at the university on dust emissions in grain elevators provided the basis for the Oklahoma's Clean Air Act requirements and saved state businesses millions of dollars in unneeded compliance fees. The data from these studies have shown the current U.S. Environmental Protection Agency's standards to be seriously flawed. The EPA has been petitioned to use the university's data for all U.S. standards on dust emissions in grain elevators.

■ Tennessee State University

The effects of changes in the Earth's climate as it relates to global warming have been the focus of work by researchers at the university. Using robotic telescopes to study stars similar to the sun, these scientists seek to predict changes in Earth's climate and then relate it to trends in global warming.

■ Texas A&M University

In the 1970s, researchers studying crystalline silico-titanate (CST) substances as possible catalysts discovered that these substances also could strip radioactive elements from wastes. Through research at the university in the past five years, CST substances have been developed to remove highly

radioactive metals from the millions of gallons of wastes stored in the U.S. After removal, these radioactive elements can be converted to ceramic waste forms. The remaining decontaminated wastes then can be stored at low-level sites.

■ University of Idaho

Researchers at the university have developed a new bioremediation process that will safely and inexpensively remove munitions' contaminants, such as trinitrotoluene (TNT), from soil and water.

■ University of Kentucky

Researchers at the university have developed a new recycling process for plastic and rubber waste products. Called "waste-coal co-liquifaction," the new process will recycle nearly 100% of waste plastic into oil and convert tires back into oil and valuable carbon black.

■ University of Maine

Over the past several years, University of Maine researchers have achieved many breakthroughs in the environmental sciences area. Of particular note is research conducted on radon gas and acid rain. Two areas of key concern worldwide, the university's research has received attention from several entities including federal agencies such as the EPA.

■ University of Maryland System

In the early 1970s researchers at the university began studying the Chesapeake Bay striped bass. Using ear stones (the bone in fish responsible for hearing and remaining upright) from striped bass, scientists found that several generations of striped bass were missing over a ten year period. Very few fish had matured and successfully spawned during those years—a sign that heavy fishing was preventing the resource from replenishing itself. A five-year moratorium on Chesapeake Bay striped bass was initiated in 1985, which at the time was considered a drastic measure. The striped bass population has since recovered and as of January 1995, was at a level the university no longer considered endangered.

■ University of Memphis

Molecular biologists at the university have developed an environmentally safe way of controlling the mosquito population. Through successfully splicing a Bacillus thuringiensis (BT) gene into a common blue-green alga, scientists were able to modify mosquito larvae's primary food source (the common blue-green alga) with the BT gene which is toxic to mosquito larvae. After eating the modified alga, mosquito larvae die. The toxicity introduced into the alga is limited to the mosquito and certain black-winged flies.

■ University of Minnesota

Ecologists at the university did the first study to clearly show that biodiversity stabilizes ecosystems and strengthens their ability to recover from damage. The study findings carry implications for forests, wetlands, cultivated land and even urban lawns, all of which may be more stable and recover faster from drought, disease, and other stresses if they harbor many plant species.

■ University of New Hampshire

The Greenland Ice Sheet Project (GISP II) currently underway at the university is analyzing the world's longest ice core (3053 meters). Researchers are reconstructing climatic history from actual chemical and physical evidence, which goes back more than 100,000 years. To date, this

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odorless, easily transported and storable for three years. The pellets are currently being used by industries to substitute for coal as a fuel source for furnaces.

■ **University of Oklahoma**

Basic research in atmospheric sciences conducted by researchers at the University's Cooperative Institute Mesoscale Meteorological Studies and the Center for Analysis and Prediction of Storms has led to better weather prediction. Of particular note is the installation of a series of highly sophisticated weather monitoring stations across the region that has helped farmers and other businesses that are highly dependent on weather.

■ **University of Tennessee**

One project at the university focuses on the use of ion exchange resins to remove pollutants from the emissions of fossil fuel fired power plants. Other work has led to the development of new technologies, such as an expert system to predict the hazard/risk factor of toxic industrial compounds. The system enables researchers to determine hazards due to chemical pollution. In addition, other researchers have developed technology that detects individual molecules in liquid, which opens the door for more precise environmental monitoring.

■ **University of Texas at San Antonio**

Bioremediation as a method for cleaning up toxic waste has show much promise over the past several years. Researchers at the university have isolated more than 1000 different microorganisms that are able to metabolize hydrocarbons and pollutants. This work has greatly expanded the potential of bioremediation as a viable method for eliminating toxic waste.

■ **University of Virginia**

Reducing toxic emissions from various manufacturing processes is seen by many as a key to improving environmental conditions. Researchers at the university are working on an environmentally conscious closed system design in chemical engineering to prevent harmful emissions during the manufacturing process. Other work at the university involves improving metal containers for liquid beverages.

■ **Virginia Polytechnic Institute and State University**

Because of its inherent flow properties, mercury is a key component in any basic "on-off" switch used in thousands of modern conveniences—from toys and autos to thermostats and street lights. But in the environment mercury is changed into toxic compounds. Chemical researchers at the university have developed liquid metal alloys and electrical switches to replace the environmentally hazardous mercury switch. These metal alloys are non-toxic and contain no materials that are harmful to the environment.

6. Assuring the Quality and Safety of Food for the Table

Food is one of the basic necessities of life. Even as technology transforms almost every facet of our lives, this fundamental need for food remains as central to our basic existence as ever. At many NASULGC universities this fundamental need is the focus of a wide range of research programs, research that is improving the quality and assuring the safety of foods we eat.

■ **Alcorn State University**

Salmonella and other like pathogens are major contaminants of poultry. Researchers at the university have developed an anti-microbial bath that reduces the presence of these pathogens. The new bath uses hydrogen peroxide rather than chlorine as the active agent, thus reducing contamination by a factor of three.

■ **Florida State University**

The presence of bacteria in seafood can be either completely harmless or extremely dangerous. Biologists at the university have developed a powerful DNA probe that is capable of identifying dangerous bacteria in oysters faster than any other technique currently available.

■ **Iowa State University**

Researchers at the university have developed a new low-palmitic acid soybean technology that substantially reduces the saturated fatty acid content of soybean oil. The new technology will not only provide a healthier cooking oil, but will also allow U.S. soybean producers to be more competitive in edible oil markets.

■ **Kentucky State University**

Scientists at the university have demonstrated that plastic mulches increase the fruit yield of horticultural crops such as tomatoes, peppers, and okra. The mulches reflect a higher ratio of far-red to red light compared to sunlight and will be available commercially within a year or two.

■ **North Carolina State University**

Processing food for human consumption requires a careful balancing between eliminating harmful agents present in the food and maintaining or increasing nutritional value.

Researchers at North Carolina State University have developed an ultra-high temperature pasteurization process for liquid eggs that not only increases their shelf-life but significantly reduces the risk of tainted eggs and egg products. In addition, the researchers have created a process to add sweet acidophillus and lactobacillus to milk and other diary products. The presence of these bacteria are thought to add nutritional value, reduce intestinal and colon cancer, and reduce acute sicknesses due to interior bacteria. These new sweet acidophillus products are not only nutritious but insure that both acidophillus and lactobacillus become a normal part of the human intestinal microflora.

■ **Southern Illinois University at Carbondale**

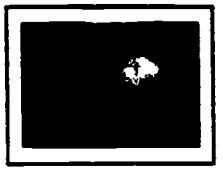
A consortium of five Midwestern universities, led by Southern Illinois University at Carbondale and funded by the North Central Soybean Research Program, is collaborating in the laboratory, greenhouse and field to unravel the mysteries of soybean sudden death syndrome, a fatal, incurable fungus blighting fields from Mississippi to Michigan. The consortium's plant breeders, pathologists and molecular scientists aim to create a line of disease-resistant beans for the northern growing region and to discover enough about the origins and workings of the disease to be able to knock it out altogether.

■ **University of Alaska**

Researchers at the university's Fishery Industrial Technology Center in Kodiak, Alaska have developed a parasite sensor that takes advantage of a fish fillet's natural tendency to conduct electricity. The new sensor system, which is currently being used by Alaskan cod and pollock processors, sends a low voltage current through a fish fillet and measures its electric conductivity. Since cod conducts electricity about 200 times better than parasites, any parasites present are detected immediately and the fish can be quickly removed from the processing line.

■ **University of California, Davis**

A new way of shipping fresh produce that puts fruits and vegetables "to sleep" for the journey while destroying hitchhiking insects has been successfully demonstrated by a collaborative project involving the military, industry and a team of researchers at the university. The pesticide-free process



helped rescue more than $60 million in annual California produce sales and will save the U.S. Department of Defense several million dollars annually in freight costs. The new process involves controlling an atmospheric mix of oxygen and carbon dioxide gases in specially adapted shipment containers so that produce is preserved and hitchhiking insects are destroyed.

■ **University of Maryland Eastern Shore**

Researchers at the university discovered an amino acid analog that demonstrated nutrient partitioning effects when administered to meat producing animals. Animals who consume the amino acid analog produce less carcass fat. Both consumers and animal producers benefit from this discovery. Leaner meat offers valuable health implications to the consumer, and animal producers realize economic benefits from feed cost savings. Other work at the university has led to similar breakthroughs. In the area of soybean production, researchers identified the optimal doses of methanol and nitrogen that can increase soybean productivity by 40 percent. In the area of fish production, research has yielded a re-circulating system that is maintenance-free. Using amphipods, the system is virtually self-cleaning and provides a highly efficient, economical approach for fish production.

■ **University of Maryland at College Park**

Basic studies on several chicken viruses by university researchers have led to the development of cost-effective vaccines and diagnostic tests. These developments contribute to the poultry industry's efforts to provide consumers with high quality products at affordable prices.

■ **University of Massachusetts at Boston**

Basic research on the hardening of the protective outer covering of insects conducted at the university has culminated in the discovery of new enzymes and the control mechanisms involved in this process. Potential applications of these discoveries are far reaching—from strengthening the fibers in natural silk to preventing food products from browning to the possible development of new types of insecticides.

■ **University of Montana**

Researchers at the university have developed a compound that has the potential for producing healthy animals with minimal antibiotic use. The new "Carmel" compound contains high fructooligosaccharides that when added in small quantities to the feed of animals (including humans) has the effect of promoting bifidobacteria (decreasing the presence of harmful bacteria).

■ **University of Rhode Island**

An interdisciplinary team of scientists at the university has developed a new biosensor that quickly and effectively detects toxins and contaminants in food. The new sensor is so effective at detecting toxins in fish that their presence in a day's catch can be determined before the fish leave the dock for the marketplace. Currently, it takes days for government inspectors to obtain samples and transport them to labs for complicated and expensive analyses.

■ **Utah State University**

Food scientists at the university have developed an Ultra High Temperature pasteurization process to sterilize raw meat and give it a cooked appearance. When combined with controlled atmosphere packaging, the shelf life of refrigerated meat is extended from a few days to many weeks. The meats are ideal for microwave cooking and appear as if charbroiled. The flavor and juices are sealed into the meat resulting in more flavorful and juicier servings.

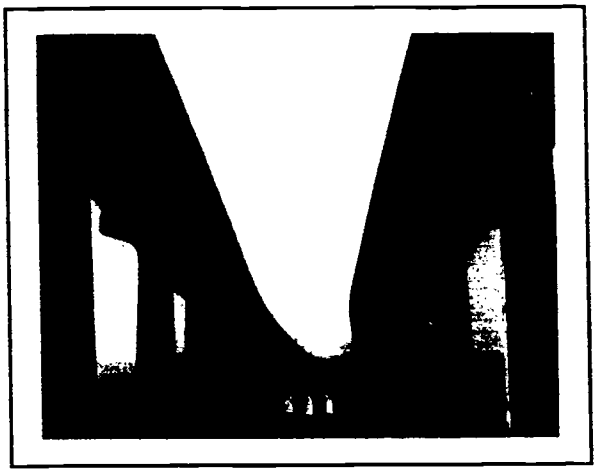
■ **Washington State University**

A team of scientists at the university's Institute of Biological Chemistry have isolated and synthesized the first polypeptide hormone ever found in plants. The hormone—systemin—was isolated in tomato plants. Systemin induces the synthesis of defense proteins called proteinase inhibitors, which are part of the plant's natural defense system used as protection against the attack of pests. This breakthrough could lead to the development of more pest-resistant plants.

■ **West Virginia State College**

Nitrogen-fixing crops such as soybeans are vital to world food supplies. To better understand how these type of crops defend themselves against harmful toxins, biologists at the university are conducting research on soybean root nodules to identify the mechanisms that remove toxic forms of oxygen (such as hydrogen peroxide) from the cellular environment.

7. Safer Buildings, Roads and Bridges



Advances in materials and structural design over the past several decades have led to safer, more resilient and stronger homes, office buildings, bridges, roads and other structures. Thanks to university research, today's structures are designed to withstand the effects of natural disasters such as earthquakes, are more environmentally sound, and use more cost-efficient structures. Many NASULGC members are taking the lead in providing better homes, work places, highways and bridges.

■ Kansas State University

Civil engineering professors at the university have developed what could be the next wave in earthquake-proofing for high-rise buildings and bridges. They have come up with an advance in base isolation systems that lets the foundation of a structure move with the earth while buffering the upper stories or decks. Their patented invention relies on commonly-used construction materials, such as concrete and steel pipes, and on standard construction methods, making the new system relatively inexpensive to install.

■ Texas A&M University

Studies of evacuation behavior following the World Trade Center bombing reveal that social relationships between people who work together maybe even more helpful at saving lives during a disaster than the widely accepted "fire drill." The research, conducted by researchers from the university's Hazard Reduction & Recovery Center, is designed to determine how Search and Rescue and Emergency Medical Services systems perform in disaster situations.

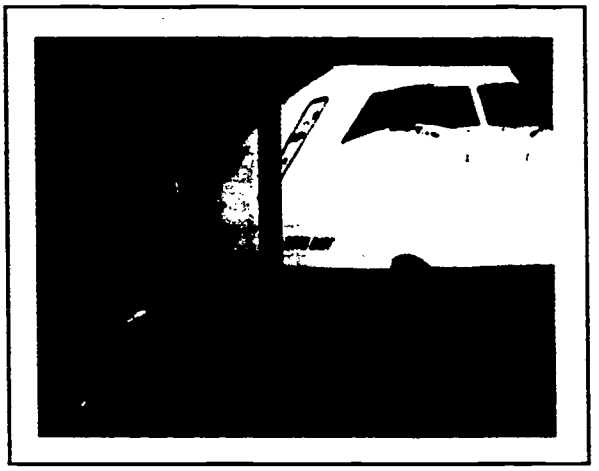
■ University of Kansas

Research engineers at the university have redesigned the steel reinforcing bar that is used in concrete in slab foundations of houses, in bridge decks, and in columns. The researchers focused on the various ribbing patterns of reinforcing-bars. In one of these patterns, raised ribs snake along the length of the bar, like the stripes on a barbershop pole. The researchers' innovation increased the rib area by making the ribs higher and spaced them closer together than in existing patterns. Under some circumstances, this larger rib area increased the bonding strength of the steel to the surrounding concrete. It is estimated that if the new pattern were widely adopted, the need for steel would be reduced by two percent, which would translate to savings of $100 million a year.

■ University of Missouri-Kansas City

Basic research in material composition has yielded a plethora of new materials that are stronger, more durable and less expensive to use. Through basic research at this university, researchers have determined the atomic-scale properties of holes, voids, and free volumes that are crucial to the performance of plastic materials used in beverage bottles and other containers.

8. Better Planes, Trains and Automobiles



Today, planes, trains, and automobiles are our standard modes of transportation. The next generation of vehicles could be as superior to our current ones as today's cars are to the horse and buggy. Ongoing research on better forms of transportation at NASULGC universities is not only making today's planes, trains, and automobiles safer and more efficient; it could result in the creation of brand new ways to get from place to place.

■ **Ohio University**

U.S. airlines may have been saved as much as $4 billion in future expenses when the International Civil Aviation Organization scrapped a mandate requiring installation of microwave-based automated landing systems. The key reason for the move was Ohio University's Avionics Engineering Center successful testing of a new automated landing system. The new system employs the satellite-based Global Positioning System (GPS), a worldwide navigation system that could save money by more direct routing of the aircraft and open more runways during severe weather events.

■ **University of Maryland at College Park**

Researchers at the university's high tech incubator program developed an unmanned aerial vehicle dubbed "The Freewing Tilt Body." The new vehicle is stall-resistant and can take off and land like a helicopter. It is designed to significantly reduce in-flight turbulence and is slated to be used for surveillance and other military applications.

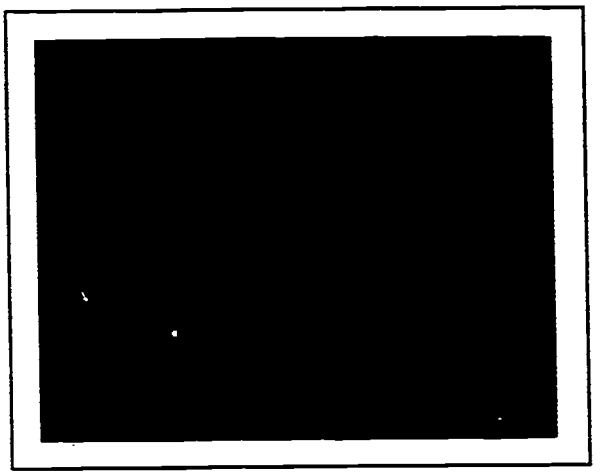
■ **University of Tennessee**

From autos to space shuttles, bodies and components are made from advanced materials formed by bonding or joining different types of substances. Heat is used in the joining process, which causes thermal stresses that can weaken the new materials. At the University of Tennessee's Space Institute, researchers have developed a new technique for bonding ceramic materials to other ceramics and to various forms of metal, the Laser Induced High Temperature Reaction Joining Process, which reduces or eliminates the thermal stresses.

■ **University of Tennessee**

Basic research at the university on flow control as applied to cavity flows will allow aircraft designers to reduce significantly high amplitude noise in aircraft, making aircraft safer and more efficient. Other research efforts at the university are focused on the development of a jet fuel laser ignition system that would enable safer, more efficient aircraft engine systems.

9. Protecting the Energy Supply



Economic growth and increased productivity are tied to the availability of safe, cost-efficient energy sources. Research at many NASULGC universities explores new energy sources and more efficient ways of using current supplies as they try to meet the nation's growing concern over the depletion of natural resources that provide much of our current energy.

■ Oregon State University

Basic research at the university on the conversion of electrical to mechanical energy has created a new type of energy conversion device for electric motors and generators. The new conversion device is highly cost effective and should find applications in automobiles, electric motors, and the generators used to produce wind energy.

■ University of California at San Diego

Researchers at the university are part of the first international collaboration—The International Thermonuclear Experimental Reactor Project—to design a controlled fusion reactor. The goal of the project is to design a facility that would demonstrate for the first time the scientific and technological feasibility of fusion power.

■ University of Houston

Inclement weather—whether extremely hot or extremely cold—creates high demand for electricity, causing what electric utilities call a peak time; moderate weather conditions mean demand is low. Many electric utilities employ various technologies, such as flywheels, to store electricity during non-peak times so that it is available during a peak time. Scientists at the Texas Center for Superconductivity have developed a new flywheel design that is currently in the prototype stage. The new prototype is a promising way to store electricity more efficiently than past designs.

■ University of Texas at Austin

Basic research being done at the university on homopolar welding is being used in a complementary applied research program to develop better equipment for the deep-water production of oil and natural gas. The homopolar welding process heats and forges materials together, which both speeds and improves the laying of pipelines in deep water. Other work at the university has resulted in the development of fiber optic sensors that can be embedded in metal for use in the mammoth engines that pump natural gas through pipelines nationwide.

INDEX OF NASULGC COLLEGES AND UNIVERSITIES

University Research: Touching the Lives of All Americans was compiled from a variety of sources by NASULGC's Office of Public Affairs, which has done its best to interpret the material accurately. This publication is not intended to be an "experts list," but rather, a sampling of just a few of the many basic research achievements accomplished at NASULGC's member institutions in recent years. Since modern science tends to be collaborative, a number of these achievements were the result of cooperation with other, non-NASULGC universities and agencies.

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