



## **AMERICA'S RESEARCH UNIVERSITIES:**

### **INSTITUTIONS IN SERVICE TO THE NATION**

*"If we are to remain preeminent in transforming knowledge into economic value, America's system of higher education must remain the world's leader in generating scientific and technological breakthroughs and in meeting the challenge to educate workers."*

--Federal Reserve Board Chairman Alan Greenspan,  
February 16, 1999

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### *Executive Summary*

#### **Key Challenges Lie Ahead**

The President of the United States leads the nation in a new century of rapidly increasing change and uncertainty. This paper identifies four key areas of particular challenge to the nation:

- Sustaining economic development and global technological leadership
- Educating a knowledge-based workforce
- Ensuring continued medical breakthroughs and improving public health
- Maintaining national security in a more uncertain world

#### **The Nation's Research Universities Are Essential to Meeting These Challenges**

The raison d'être of the American research university is to ask questions and solve problems. Together, the nation's research universities constitute an exceptional national resource, with unique capabilities:

- America's research universities are at the forefront of innovation; they perform about half of the nation's basic research.
- The expert knowledge that is generated in our research universities is renowned worldwide; this expertise is being applied to real-world problems every day.
- By combining cutting-edge research with graduate and undergraduate education, our research universities are also training new generations of leaders in all fields.

### We Call Upon the President to Sustain the Partnership with Research Universities

The longstanding partnership between the federal government and the nation's research universities is entering a new era as we move deeper into a knowledge economy. We hope that the following will be possible:

- **Strong growth in research funding** at the National Institutes of Health and the National Science Foundation as well as agencies that have seen relatively little growth in research funding over the past five years. The national investment in fundamental new knowledge is key to ensuring continued technological payoff.
- **A balanced portfolio across the federal research agencies**, and a balanced combination of spending among investigator-driven research grants, training, and infrastructure support. The latter category includes research facilities, instrumentation, and equipment.
- **High priority for ensuring access to higher education** for students at both the graduate and undergraduate levels.

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### AMERICA'S RESEARCH UNIVERSITIES: INSTITUTIONS IN SERVICE TO THE NATION

The President of the United States leads the world's greatest democracy at the turn of the millennium. As we celebrate this historic moment, we also must prepare for rapid change and uncertainty. Four key areas of particular challenge will be:

- Sustaining economic development and global technological leadership;

- Educating the workforce of the future;
- Ensuring continued medical breakthroughs and improving public health; and
- Maintaining national security in a more uncertain world.

This paper discusses these challenges and the roles the nation's research universities can and will play in helping to meet them.

## Sustaining Economic Development and Global Technological Leadership

Throughout history, technology has been a powerful engine of change. But in the last two decades, a fever of technological competition has swept through the global marketplace.

Economist Robert Solow won the Nobel Prize for his paradigm-breaking research on the sources of economic growth. Economic expansion had long been measured primarily in terms of labor and capital. Solow's work determined that today, the largest portion of economic growth comes from technological change.

The U.S. has benefited greatly from its technological leadership. Largely as a result of technological innovation, the nation has enjoyed an unparalleled eight-year period of economic expansion characterized by major productivity increases, job growth, and raised living standards.

However, we cannot rely on past excellence to maintain or enhance our technological leadership. Whereas it used to take 20-25 years for a body of research to emerge in diverse market applications, the timetable now can be less than 25 months.

In addition, capable and aggressive competitors abound. Those who are not yet good innovators are often superb imitators. The cluster of nations capable of adopting and improving on every new commercial product, process, or service grows daily. In fast moving fields, advantage accrues to those who first make the breakthroughs. That is a major reason that research matters to competitive advantage.

America has strong technological prowess, but its preeminence in any area is always vulnerable to highly competent competitors. We are not leaders in every field of technology, as no nation can be. Defending our position in areas where we have current leadership will be difficult, and besting competitor nations that are ahead of us in other areas will be especially daunting.

## Educating the Workforce of the Future

Educating and training the workforce of the 21<sup>st</sup> Century will require the concerted and collaborative efforts of all sectors of our economy, not just educational systems. As information technologies become the primary infrastructure of the future, education will not end with a diploma or a degree; effective workers and citizens will need to be perpetual learners.

As workers, Americans will need to adapt to a constantly changing, fast-paced work environment that may include dealing with coworkers across the country or around the world. This requires not only technical skills, but also the ability to understand and work with those from different backgrounds and cultures. As citizens, Americans also will need a broad understanding of our society and the world in order to evaluate a torrent of information and make informed choices about their personal lives and about the life of the nation as a whole.

To provide continued progress and leadership, the country also must pay attention to the education of the next generation of scientists, educators, and leaders in government and industry. These individuals will be the prime movers behind the health of our economy, the well-being of our citizens, and our role in the world. They must not only be well grounded in their specific areas of knowledge, but also understand the values of our society and the new global society.

Despite the importance of the sciences and technology to our modern world, we cannot forget that important and inspiring knowledge is not limited to these areas. Science may be better equipped to explain the physical world, but the arts and humanities give meaning to our existence. We need to balance our intense scientific and technical focus with fields that enrich and enlighten the human spirit. New knowledge must include strategies for institutions and individuals to deal with change and find meaning in the world.

In addition, the nation's demographics are changing rapidly. It will be critical that no segments of society be left behind as we move forward in this new, knowledge-based economy.

## Ensuring Medical Breakthroughs and Improving Public Health

Health problems-large and small, esoteric and common-touch every citizen and family in the nation. Some of these problems, such as cancer, cardiovascular disease, diabetes, and birth defects, are as old as humankind. Others-AIDS, for example-are more recent. Now, with life expectancy increasing further, we are confronted with new challenges such as the escalation of Alzheimer's and other forms of dementia in the aged. The

economic and social implications of this vast societal change are enormous. We face other new public health challenges as well:

- **The transmission of infectious diseases across borders and around the globe poses an increasing threat.** The world is growing smaller every day through advanced transportation, population growth, and overall global mobility. Travelers can carry a virulent disease to the other side of the globe in a matter of hours. We will not only need creative strategies for immediate identification of new diseases but also for their containment.
- **Overzealous use of antibiotics poses another new and dangerous set of problems.** Unique and more virulent strains of old, controllable diseases are appearing. Some are proving to be resistant to antibiotics that were effective on milder strains fifteen years ago. Without a whole new generation of pharmaceutical remedies, we could face recurring outbreaks of epidemic proportions.
- **The connections between environmental degradation and human health problems present yet more concerns.** The rise in skin cancer being attributed to the hole in the atmospheric ozone layer may be just the beginning of our understanding of environmental impacts.

## Maintaining National Security

America's defense preparedness has, on many occasions, deterred or contained our enemies and protected our citizens and our democracy. To be prepared is not only pragmatic, but essential to survival.

Since the end of the Cold War, the world has become a more uncertain place. Along with the need to be prepared for conventional battlefield conflicts, new and different threats have emerged:

- **A growing number of rogue nations now possess nuclear expertise and materials.** The old challenge of monitoring a bear in the woods has been replaced by a task more akin to keeping track of a swarm of bees.
- **Terrorism is a new and volatile language.** Victims of terrorist acts are most often innocent citizens. Bio-warfare is perhaps its most treacherous application but all forms of terrorism are unpredictable and irrational. These threats will require innovative approaches if we are to maintain national security and world stability.
- **Vulnerability to cyber-terrorism is increasing** as communication and information technologies become inexorably linked with economic growth and

the daily function of everything from stock markets to families. A single individual can disrupt and even disable national networks and millions of terminals. A computer virus can become the "black plague" of the information superhighway. The ramifications are as far-reaching as the imagination. Security measures must be developed to match the threats.

## **THE NATION'S RESEARCH UNIVERSITIES ARE ESSENTIAL TO MEETING THESE CHALLENGES**

World War II was a defining event in the role of U.S. research universities. The war effort required immediate knowledge and innovative technologies to outmaneuver our enemies. With their scientific facilities and bright minds, the research universities provided these capabilities. In one of the classic partnerships of modern history, the federal government and the universities joined national need and national expertise.

Science and technology made major contributions to the war effort. This, in turn, paved the way for the highly effective university-government partnership to continue and expand in ways that have served pressing national needs in many areas.

A hallmark of the American university system is the marriage of research with the training of the next generation of scientists and engineers. This combination provides an extraordinary synergy in a nationwide system of diverse institutions. It ensures continuity between the newest thinking in every field and those who will carry its seeds into industry, medicine, public service, and the perpetuation of enlightened teaching and training. The integration of research and education has become a model for universities around the world.

Research universities have remained steadfast to the highest standards of scholarship and inquiry but at the same time have evolved to meet changing societal needs. They have been the wellspring of new information and better understanding of historic information.

As society becomes increasingly knowledge-based and driven by information technologies, the role of the research university will become larger and ever more central to national prosperity.

The unique amalgam of inquiry and education has repeatedly produced not only a stream of new knowledge, but also insight and innovation often coming from the undergraduate and graduate students who are an integral part of the system.

These students have been trained by master teachers and have been given the freedom to take new risks, ask new questions, and even forge new fields. They become the high-

value workers across the whole society-in industry, government, medicine, and public life.

## The Research University Role in Economic Development and Global Technological Leadership

The nation's research universities perform about half of the nation's basic research and about 12 percent of its applied research. A recent study conducted by Dr. Francis Narin and others<sup>1</sup> clearly demonstrates that university research is a primary source of innovation and benefits to society: the study indicates that this research accounts for more than half of the papers cited on U.S. patents. In short, the momentum created by university research-and by the education and training that are interwoven with it-undergirds and primes our world-class economic engine. For example:

- University research in fiber optics and lasers helped create the telecommunications revolution that has brought about unprecedented economic expansion for America.
- Recombinant DNA research at our universities in the 1970s opened the door for today's multi-billion dollar biotechnology industry.
- University research revolutionized agriculture by developing vaccines and treatments that have eliminated or controlled hundreds of plant and poultry and livestock diseases, and by developing high-yielding, disease-resistant fruits, vegetables and grains.
- Pioneering research at universities in satellite camera technology has led to the precise photography vital for space exploration, weather forecasting, environmental monitoring, and military surveillance.

## The Research University Role in Educating the Workforce of the Future

The nation's research universities educate nearly a third of all the nation's undergraduates and three-quarters of the nation's Ph.D.s. They produce virtually all of the advanced degrees awarded in cutting-edge fields, such as molecular biology and computer science. They house the nation's leading schools of medicine, engineering, business, public policy, and law.

The nation's research universities are at the forefront of the current educational revolution: integrating the new learning technologies into their classrooms and expanding opportunities for distance learning, updating curricula to prepare students for careers that cross disciplinary and cultural boundaries, and creating partnerships with

school systems, government, and industry to improve education at all levels.

## The Research University Role in Medical Breakthroughs and Improving Public Health

Through research in their medical schools and related university departments, the nation's research universities have played a key role in developing many of the drug treatments, vaccines, medical procedures, and devices that have improved the nation's public health in recent years. A child born today in the United States can expect to live 76 years, nearly four years longer than a child born as recently as 1975.

University researchers are currently on the threshold of major advances, if not outright success, in healing or repairing many human health maladies. Progress is being made in everything from nerve cell regeneration to freeze-dried blood platelets. These advances give us hope for a healthier future.

An improved understanding of molecular biology can result in more efficient and effective pharmaceutical research, which can expand the number of lifesaving drugs and lower the costs of drug development.

Research on the fundamental biology of disease mechanisms and the modification of those mechanisms can reduce chronic disability among the elderly. This, in turn, can reduce the costs of hospital and nursing home care.

A better understanding of human genetics promises to revolutionize the prevention and treatment of disease, perhaps eliminating such inherited afflictions as sickle cell anemia and Lou Gehrig's disease, and creating new treatments for cancer and heart disease.

## The Research University Role in Maintaining National Security

Military technologies and weapons systems based on university research have played a key role in the nation's successful defense since the days of World War II. University contributions in this area have included radar, inertial navigation, precision guidance, advanced materials, and stealth technology.

Currently, university researchers are:

- Developing remotely-operated mini-robots that can survey battlefields and urban landscapes without danger to their users;
- Creating highly sensitive chemical and mechanical sensors that can identify minute amounts of dangerous substances in the environment;

- Using networking, supercomputers and advanced software to develop very large-scale battlefield simulations to improve training, assess new weapons and tactics, and analyze battlefield data; and
- Working to create protein-based data memory systems, similar to the brain, that can store and retrieve vastly increased amounts of video, audio, and other complex data.

## **WE CALL UPON THE PRESIDENT AND CONGRESS TO SUSTAIN THE PARTNERSHIP WITH RESEARCH UNIVERSITIES**

*"The Council's bottom line is that the United States is reaping the benefit of past investments in innovation without investing enough in the creation of new knowledge and the development of the nation's talent pool. Meanwhile, the national assets that have set the U.S. economy apart historically may not create as great an advantage in the future as they have in the past."*

*--Council on Competitiveness, "Competing Through Innovation: A Blueprint for American Leadership," December 1999.*

This is a key time for increased investments in university research. We are on the threshold of breakthroughs in many areas—from new insights about the origins of our solar system to new drug compounds to treat disease. The opportunities are growing. But many technologies of today are based on research done 20 or more years ago. The national investment today in fundamental new knowledge is key to ensuring continued technological payoff.

The nation's research universities greatly appreciate that members of Congress, on a bipartisan basis, have understood the importance of university research and education and have worked to sustain funding for these areas.

We hope that with the President's strong support, the following will be possible:

**Enhancing the national research enterprise.** We look forward to continued strong growth in research funding at the National Institutes of Health and the National Science Foundation. We also hope that ways can be found to bolster research funding significantly at agencies that have seen far less real growth over the past five years. We are eager to work with the President and Congress in these efforts and to ensure that research funds are spent most productively.

**Balancing the portfolio of federal research.** A strong national research enterprise requires a balanced portfolio across the scientific and engineering disciplines. We have

seen time and again that research developments in one field can revolutionize work in others. Breakthroughs in medical research and treatment, for example, often are dependent on tools developed in the physical sciences such as magnetic resonance imaging machines, which were developed from basic research in nuclear physics, chemistry, and mathematics. As the President and Congress make decisions on the most effective means of investing additional federal research dollars, we also urge the following: a balanced portfolio across the federal research agencies, and a balanced combination of spending among investigator-driven research grants, training, and infrastructure support.

**Investing in students.** Increased federal support for research at universities is a two-fold investment for the nation. Not only are university researchers pushing back the boundaries of knowledge, but through the graduate and undergraduate students who participate in research projects, they are training the next generation of leaders in academia, high-technology industry, and government. But the education that is carried out through research funding is only part of the story. We also urge the President and Congress to place a high priority on ensuring access to education for students at all levels, including graduate and undergraduate students.

## CONCLUSION

The *raison d'être* of the American research university is to ask questions and address problems. Research universities have a history of contribution and a future of commitment to the nation and its citizens. We look forward to a strengthened university-government partnership to address the challenges that will face the nation in the new century.

The government-university partnership is entering a new era as we move deeper into a knowledge economy. Research universities will play a continuing role in generating the knowledge that will be needed to address our challenges. The nation's academic talent pool is formidable. It should be used to its fullest in serving all our citizens.

We share these glimpses of some important issues on the nation's-and the world's-agenda for the 21<sup>st</sup> century in the hope and expectation that the President of the United States, his administration, and Congress will see the federal government's partnership with universities as essential to our nation.

The nation's research universities stand ready to continue and expand this highly productive partnership as a means of improving society and the lives of individuals in the new millennium.

<sup>1</sup> Narin, Francis, Kimberly Hamilton, and Dominic Olivastro, "The Increasing Link between U.S. Technology and Public Science," *Research Policy*, 26, 3, p.317-330, 1997.