

SCIENCE AS A SOLUTION:

AN INNOVATION AGENDA FOR THE
NEXT PRESIDENT

MARCH 2008



ASSOCIATION OF AMERICAN UNIVERSITIES

SCIENCE AS A SOLUTION: AN INNOVATION AGENDA FOR THE NEXT PRESIDENT

The next President will make decisions that determine our nation's place in the 21st century. We remain the world's military and economic superpower, yet at home and abroad we face economic and national security challenges to our leadership with serious consequences for future generations of Americans. During the 2008 presidential campaign, Americans will judge candidates on their ability to lead the nation in addressing these challenges.

As each candidate considers the resources on which his or her administration might draw for ideas and talent, few are as valuable as the people and organizations that comprise America's matrix of innovation. The elements of this matrix—universities, businesses, nonprofit organizations, government agencies, and individual innovators—are seeking and creating real solutions for the challenges we face. It is this innovation matrix—decentralized, networked, cross-disciplinary, and sparked by the intellectual genius of Americans and people from around the world—that can ensure America's national and economic security and world leadership in the 21st century.

At the core of this great national innovation matrix is our system of higher education and research. This system sets the standard for the world, in part because of the autonomy and extraordinary diversity of its 4,000 institutions. Our colleges and universities educate the men and women who, in turn, create the ideas that spark innovation. Among these institutions, America's research universities serve particularly as drivers of innovation because they fully integrate research with education. With strong government support, these institutions have made America the world's leading incubator of innovators and innovation.

The 60 U.S. universities of the Association of American Universities educate more than half of the nation's Ph.D.'s and 58 percent of those in science, mathematics, and engineering. As the only American higher education association composed solely of leading research universities, AAU focuses on the current and potential contributions of such universities.

In the next few pages we offer Presidential candidates and the next administration a vision for science, technology, and education that can help ensure that the nation remains strong and capable of answering the daunting challenges we face.

AMERICA'S RESEARCH UNIVERSITIES: INCUBATORS OF IDEAS AND INNOVATION

University research is a vital building block in our nation's R&D enterprise. Universities perform 54 percent of the nation's "basic" research. Such research is aimed at increasing fundamental knowledge and understanding rather than developing a specific device or application. But new products and processes would be impossible without basic research. The competitive system of merit review—or peer review—ensures that most federal support for basic research is based on scientific merit.

The economic benefits of academic research have been well documented. One of the most comprehensive analyses concluded that the average annual rate of return to society from academic research ranges from 28 to 40 percent.¹ The successes of this system are so extraordinary that we often take them for granted. Scientific and technological advances such as the laser, the Internet, magnetic resonance imaging, global positioning systems, and even the MP3 player are results of federal investments in university research. Our nation's commerce, security, and culture would be profoundly different without the technologies that have emerged from university research.

Moreover, this system is a "twofer." U.S. universities use their research activities not only to create the new knowledge that provides the foundation for new products and processes but also to educate the next generation's scientists, engineers, teachers, and leaders in government and industry. More likely than not, the next significant advance in technology will come from the federally supported research of scientists and engineers who earned their degrees working as graduate students in university laboratories substantially funded by federal research agencies.

At one time, the federal government's system of supporting basic research and graduate education at universities was uniquely American. But a number of our European and Asian economic competitors have recognized the value of this system and are adopting the American model rapidly and effectively. As global competition in science and technology intensifies, America must work harder to retain our lead.

A HALF-CENTURY OF INNOVATION ADVANCES

Fifty years ago, on October 4, 1957, the Soviet Union launched Sputnik, a tiny satellite that shocked the nation and signaled the possibility that American scientific preeminence had been overtaken by our Cold War adversary. Sputnik triggered, virtually overnight, a national strategy of investing in education and research to reclaim American scientific and technological leadership.

Congress vastly strengthened the government's scientific enterprise, creating new agencies such as the National Aeronautics and Space Administration (NASA) and the Defense Advanced Research Projects Agency. In just four years, Congress doubled the federal R&D investment and tripled funding for basic research at the National Science Foundation (NSF), the National Institutes of Health (NIH), and other agencies. Much of this funding

¹ Edwin Mansfield, "Academic Research and Industrial Innovation," *Research Policy* 20, no. 1 (1991): 1-12; and Edwin Mansfield, "Academic Research and Industrial Innovation: A Further Note," *Research Policy* 21, no. 3 (1992): 295-96.

was invested in universities, the government's main partner in basic research.

At the same time, the National Defense Education Act of 1958 created new programs to improve the teaching of science and mathematics in elementary and secondary schools; created new graduate fellowships to strengthen Ph.D. programs in all disciplines; provided need-based, low-interest student loans to undergraduate and graduate students; and expanded instruction and teacher training in foreign languages and cultures.

Together these measures created an unrivaled research and education enterprise that helped quadruple the number of U.S. Nobel prize winners in science in the second half of the 20th century and led to discoveries that transformed the country and much of the world.

THE FUTURE OF U.S. SCIENCE AND INNOVATION

To maintain America's global leadership, we must build on our history of scientific advancement to revitalize our innovation system for the 21st century. In fast-moving fields, competitive advantage accrues to those nations that make research breakthroughs. Others are investing heavily in scientific research and facilities because they recognize the benefits of building a strong internal science capacity. We need a long-term plan to keep America in the forefront of scientific advancement and innovation.

To ensure a robust system of science and innovation, AAU calls upon the next President to do the following:

- **Harness the nation's innovation matrix to help address major national and international challenges;**
- **Expand and nurture U.S. talent in science, mathematics, and engineering to create a workforce ready to meet the innovation challenges of the 21st century;**
- **Reaffirm and strengthen the government-university partnership; and**
- **Elevate the role of science in White House policy decisions.**

Following is a more detailed discussion of each of these recommendations.

1) Harness the nation's innovation matrix to help address major national and international challenges.

In his seminal 1945 report to President Truman, *Science the Endless Frontier*, Vannevar Bush recognized the important role that science and universities could play in addressing issues of vital national importance relating to health, the economy, national security, and quality of life. This vision led to the unique system of government support of science at universities described above.

University research and the people who conduct this research are an important part of the solution to nearly every major challenge facing our country. Recognizing this, AAU calls upon the next President to use interagency,

multidisciplinary scientific initiatives to coordinate and harness the tremendous resources and talent at our universities and elsewhere. Following are some of the national and international challenges for which science is an important part of the solution:

- **Energy self-sufficiency.** Basic research is critical to the development of alternative forms of energy as well as conservation of fossil fuels. The nation must develop the research and talent base needed to meet future energy needs and ensure our future energy independence. Existing resources are not sufficient. It will take a significant commitment to develop a foundational research base in renewable and energy-efficient technologies in areas such as biofuels, solar, wind, geothermal, fusion, coal, and nuclear fission.
- **Environment and climate change.** Beyond contributing to conservation and alternative forms of energy, additional basic research is essential to understanding and addressing major environmental problems, including climate change. Significant efforts must be devoted in the next administration to carbon dioxide mitigation and to learning how to address the likely effects of climate change. A comprehensive approach to addressing this far-reaching problem will require an effective multidisciplinary engagement of physical and biological sciences, social sciences, and engineering.
- **Twenty-first century life sciences.** In the past two generations, U.S. health care has advanced from relieving symptoms and pain to intervening in the disease process and preventing death. A new administration can spark the next transformation in health care to personalized, molecular medicine, using knowledge from the sequencing of the human genome to prevent cancer and other diseases. Life sciences research of the 21st century can also provide solutions for new and emerging pandemics and the diseases of the developing world, global climate change and our need for alternative energy sources, and spark another green revolution in sustainable food production.
- **National and homeland security.** University research has played a major role in developing the technologies that have helped make America's men and women in uniform the most effective in the world. One need only consider the impact of global positioning systems or stealth technology to realize that investments by the Department of Defense (DOD) in basic research yield extraordinary benefits to national security. Moreover, new investments in the social and behavioral sciences can help us to understand and fight terrorism. Unfortunately, Defense basic research has been neglected in recent years. To develop the technologies and strategies needed to protect the nation from a broad range of security threats, we must revitalize the investment in Defense basic research.

2) Expand and nurture U.S. talent in science, mathematics, and engineering to create a workforce ready to meet the innovation challenges of the 21st century.

There are not enough American students well-versed in science and mathematics, and too few are pursuing careers in science and technology fields. There have been recent encouraging developments in this area, including enactment of the America COMPETES Act and the establishment of new science and mathematics programs at NSF and the Departments of Education, Energy, and Defense. But more needs to be done. The next President should cultivate talent by launching a major science, technology, engineering and mathematics (STEM) education initiative. Among other things, this initiative should:

- **Increase graduate fellowships and traineeships.** The initiative should fund a substantial increase in the

number of graduate fellowships and traineeships supported by federal science and education agencies as authorized by the America COMPETES Act. This should include increased funding for such programs as NSF's Graduate Research Fellowship and IGERT programs and the Department of Education's GAANN programs, as well as funding for the new Department of Energy (DOE) fellowship program aimed at training a new generation of scientists and engineers to tackle energy security challenges.

- **Expand the DOD National Defense Education Program.** This program provides scholarships and fellowships to students in critical fields of science, mathematics, and engineering in return for a commitment of federal public service.
- **Support young scientists.** Create new sources of competitive research funding at federal science agencies targeted toward exceptional young scientists and engineers. This could include expanding existing early career award programs, creating new young investigator research awards for promising scientists under 45 years old, and grants to top postdoctoral appointees who are seeking their first faculty appointments.
- **Enhance K-12 STEM education.** Actions should include: expanded support for summer STEM and foreign language teaching institutes at universities for K-12 teachers such as those already supported by the NSF through its Teacher Institutes for the 21st Century program; creating a college mentoring and tutoring program that offers students a stipend for tutoring K-12 students in STEM and foreign language coursework; and encouraging states to create innovative programs, modeled on UTEACH and CALTEACH, to develop a larger and more diverse generation of STEM teachers.
- **Encourage the best students from around the world to study and live in the United States.** The federal government should create clear pathways to permanent residency and U.S. citizenship for talented international students who earn U.S. academic degrees, as well as for outstanding international scientists and engineers teaching and conducting research in the U.S.

3) **Reaffirm and strengthen the government-university partnership.**

Steps we take to cultivate a larger and more-highly skilled science and technology workforce will be for naught without accompanying actions to strengthen the nation's research and innovation capacity. Key to strengthening that capacity is a revitalized government-university partnership. Below are four actions to strengthen that partnership that warrant special attention from the next President.

- **Provide adequate resources for basic research.** There is strong support within the current administration and Congress to increase funding for key federal research agencies, particularly NSF, the DOE Office of Science, and the National Institute of Standards and Technology. But the bipartisan agreement on the need for greater funding of basic research has been stymied by the larger budget battles between the White House and Congress. The nation's innovation system cannot afford another year of dismal basic research funding, as the FY08 appropriations process produced.

AAU calls upon the next President to increase funding for these agencies over a seven-year period in accordance with the recommendations in the National Academies' 2005 report, *Rising Above the Gathering Storm*. Similar increases should be provided to other key research agencies, including the Department of Defense and NASA. Finally, NIH's budget has been cut by nearly 15 percent since 2003, when adjusted for inflation. Sustained and steady growth is critical for medical science that can take years to plan and

perform. The next President should restore our nation's biomedical research capacity and restore funding for NIH to historical rates of growth.

- **Support continued university technology transfer.** Our government must continue to encourage the transformation of cutting-edge basic research into commercial products and medical advances for the public good. We can do this by continuing to abet collaboration between private sector firms and federally funded scientists at universities and federal laboratories. The Bayh-Dole Act, which provides universities and companies an effective incentive for developing new knowledge generated with federal funding, should be preserved. It has proved a valuable and uniquely American means of transferring the fruits of scientific discovery to broader societal benefits. Other countries, such as Japan, seeing its wisdom, are considering creating a similar system.
- **Ensure that research decisions are based on scientific quality.** Merit review of research grant proposals helps protect the taxpayers' investment in science. The President and Congress are responsible for ensuring that appropriate policies and procedures are in place to determine the allocation of scarce funds. By protecting the scientific peer review system, where research proposals undergo rigorous review for scientific quality, the President and Congress can help ensure that only high-quality research is funded with federal dollars. The next President should take a strong stand against research funds allocated by means other than peer review.
- **Establish a new federal government advisory committee on the university-government partnership.** The post-World War II basic research partnership between the federal government and universities has been a fundamental reason for American leadership in science and technology. But recent developments threaten this unique partnership, undermining universities' ability to conduct important research on behalf of the federal government and the American people. These include increasing federal regulations and associated compliance costs; arbitrary restrictions on reimbursement to universities for the costs of conducting federal research; and growing restrictions on communication of, and access to, scientific results.

Because the continued health of the federal government-university partnership is vital to the nation's future, AAU urges the next President to establish a new federal advisory committee aimed at maintaining and strengthening this partnership. The panel should be composed of a select group of university presidents and key administration officials and be able to respond to issues as they arise so that this partnership continues to thrive and serve the nation's needs. The committee should be tasked immediately with assessing the enterprise's current health and providing a report to the President with recommendations that can be implemented to strengthen the partnership in the public interest.

4) Elevate the role of science in White House policy decision-making.

Many of the issues facing an administration require scientific knowledge and expertise. To ensure that science is adequately incorporated into policy making, the next President should give high priority to seeking and seriously considering scientific advice. Here are specific ways to give science its appropriate role in policy making:

- **Raise the status of the President's science advisor.** The science advisor should be designated as an Assistant to the President and/or sit with the President's cabinet. The President needs a science advisor with the authority to ensure that Presidential programs include appropriate components related to science,

research, and technology and to ensure that administration officials and agency heads respect the role of science in making decisions.

- **Respect and use the recommendations of scientific advisory committees.** Scientific advisory panels exist throughout the government, including the President’s Council of Advisors on Science and Technology. The next President should see that only individuals with strong scientific credentials are assigned to serve on these advisory committees. The President should heed these committees’ advice and recommendations and encourage Cabinet officials to use their recommendations as well.
- **Enhance coordination of scientific research across the government.** The National Science and Technology Council, chaired by the President, should develop and coordinate major new cross-cutting scientific initiatives across federal departments and agencies. These initiatives should be aimed at meeting grand challenges of all kinds—including but not limited to the scientific challenges discussed above. Many of the next major scientific discoveries will be multidisciplinary, and the foundational research that goes into them will be more effectively sponsored by coordinated programs of multiple federal agencies.

CONCLUSION

America’s research universities generate human and intellectual capital that are the twin engines of innovation and economic growth. By conducting research that serves science and the public good, by teaching the next generation of leaders in every field, and by producing the ideas that advance civilization, these institutions can continue to serve as a foundation of continuing American leadership in the 21st century.

The nation’s entire higher education system plays an even broader role in society. Millions of America’s most talented young people come to our campuses to learn, discover, challenge, debate, study, cooperate, and compete. This process makes students into citizens, prepared to make our country and the entire world better. Many of them are emerging with an extraordinary determination to do just that, and they are finding ever more creative ways to do so.

The nation’s challenges are daunting. But America’s colleges and universities, particularly its research universities, will provide the people, ideas, and discoveries that will help us to meet and overcome them. To ensure the continued vitality of the nation’s research and education enterprise, the federal government and universities must work together in partnership.

As Campaign 2008 continues, we are prepared to work with candidates and their staffs to respond to their ideas on these and other vital subjects.

Ultimately, AAU and the nation’s research universities want to work with the next administration to address problems at home and abroad and maintain this nation’s global leadership in the 21st century.