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"A National Response to the President's Call for Increased Focus on Math and Science"

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Thank you for inviting me this afternoon. Earlier this morning I testified before the Senate Committee on Commerce, Science, and Transportation Subcommittee on Technology , Innovation, and Competitiveness, chaired by Senator Ensign. The topic was "*The Importance of Basic Research to United States Competitiveness*" and of course I spoke about the "*American Competitiveness Initiative*" launched by President Bush in his State of the Union message. The Initiative – I'm going to call it the ACI – has received widespread attention in the House and the Senate from both parties, and I plan to devote my prepared remarks to it and then answer questions.

The ACI has several components, addressing research, technical workforce issues, and education. I am sharing the platform on this panel with Deputy Secretary of Education Ray Simon who can speak more knowledgeably about the education components than I can, and I will concentrate on the research components. In either case, it is important to recognize that the federal government is already operating a large number of programs in research, education and training, and the ACI has to be understood in context. One of the confusing aspects of the public discussion of this initiative is that the reports that led up to it have not attempted to integrate their proposals with existing programs, so it is hard to tell whether something really new is being proposed, or an enhancement of an existing program, or an endorsement of a good idea that may or may not already be in practice.

There is no longer any question that America's economic strength and global leadership depend on technology-based innovation. The innovation could be in entirely new technologies, in specific applications of technologies, or in a business model – a way of providing a service, new or old, that is new or better than existing ways. A good example of all three, featured in the ACI brochure, is the MP3 player. Apple's iPod, for example, combines a micro-hard drive storage device, LCD display, and compact memory and processor chips in a tiny device powered by a Lithium-ion battery and exploiting very sophisticated data compression software. All the physical components operate on basic physical phenomena discovered and studied in my adult lifetime by scientists working in university or industrial laboratories, and mostly supported with federal funds. But the iPod itself is only part of a larger concept including Apple's iTunes software and an on-line music store with a large inventory of music that consumers could purchase easily and inexpensively. The iPod is an example of a strategic, technology based innovation.

Any national policy that seeks to ensure continued innovation of this sort must include many components:

- Federal investment in R&D;
- An education system that equips Americans with a strong foundation in technical subjects;
- Universities that provide world-class education and research opportunities;

- Immigration policies that talented people from other countries to enhance entrepreneurship, competitiveness, and job creation in America;
- A favorable environment for private sector R&D; and
- A business environment that encourages entrepreneurship and protects intellectual property.

Each of these components has been discussed as having importance for national economic strength, but the recognition that they are all essential parts of an "innovation ecology" developed only within the past few years. An important precursor was a report prepared by Congressman Vern Ehlers nearly a decade ago that attempted to update and replace the classic postwar science policy document "*Science: the Endless Frontier*" written by the progenitor of all science advisors Vannevar Bush. Ehler's report, whose short title is "*Unlocking the Future,*" clearly stated the conclusion that the rationale for funding science is to ensure future economic competitiveness. This report devotes an entire chapter to the importance of education, and includes it as an essential component of science policy. While not emphasizing physical science, the report did stress that "It is important that the federal government fund basic research in a broad spectrum of scientific disciplines, including the physical, computational, life and social sciences, as well as mathematics and engineering, and resist overemphasis in a particular area or areas relative to others."

At the turn of the twentieth century, science policy makers began to worry about a growing imbalance between support for biological and physical science. Biomedical investigators were aware they depended on physical science instrumentation, and NIH leadership began to take steps to ensure access to it. Already in the late 90's NIH had transferred some of its funds to build beam lines at DOE's x-ray synchrotron facilities. In Fiscal Year 2002 expenditures for physical science by NIH actually exceeded those by NSF. Early in the new Bush Administration the President's Council of Advisors on Science and Technology (PCAST) released a report called "*Assessing the U.S. R&D Investment*" that said "All evidence points to a need to improve funding levels for physical sciences and engineering. " At the time, the country was still suffering the economic consequences of the burst dotcom bubble, and was realigning budget priorities in response to the terrorist attacks of September 2001. Completing the commitment to double the NIH budget was the highest science priority, next to establishing an entirely new science and technology initiative for homeland security. Nevertheless the Administration continued to expand funding for targeted areas of physical science, including the recently introduced National Nanotechnology Initiative, and maintained funding for the Networking and Information Technology R&D program. The NSF budget continued to increase at a rate above inflation. In the first term of the Bush Administration, combined federal R&D funding soared at a rate unmatched since the early years of the Apollo program, a jump of 45% in constant dollars over four years.

Late in 2004 the Council on Competitiveness combined themes from earlier studies in a document that was the first in a string of reports that appeared in 2005 and which pulled together many of the various pieces of the requirements to sustain a competitive innovation economy. These reports culminated in the National Academy study entitled *"Rising Above the Gathering Storm"* which set forth twenty recommendations for federal action. The American Competitiveness Initiative is not an attempt to implement the "Rising Storm" report, but it does draw on insights from this and the previous reports to craft a specific initiative consistent with the current status of the numerous federal programs relevant to the competitiveness theme.

The ACI improves conditions for many if not all areas of physical science, but emphasizes fields likely to produce economically important technologies in the future. These are not difficult to identify, and all developed countries recognize their importance. Chief among them is the continued exploitation of our recent ability to image, analyze, and manipulate matter at the atomic scale. New technologies can be expected to spring from improved atomic-level understanding of materials and their functional properties in organic as well as inorganic systems. Physicists see exciting prospects for technologies based on quantum coherence. Chemists envision industry-transforming catalysts and new approaches to clean energy production. The convergence of nano-, info-, and bio-technology is already a familiar concept whose power has barely begun to reveal itself in applications.

Opportunities exist in energy research, environmental studies, and space science and exploration as well, and these have their own rationales and their own program structures within the federal agency structure. But they are not emphasized in the Competitiveness Initiative. Not that the U.S. is withdrawing from these fields. Some of the increased budgets in NSF and DOE will increase their vigor. The overall NASA budget, for example, is increased by 3.2% in the President's FY07 budget proposal. And the research budget of the National Oceanic and Atmospheric Administration is scheduled to increase more than 10% in FY07 (excluding earmarks). The choices of priority departments in ACI signals an intention to fund the machinery of science in a way that ensures continued leadership in fields likely to have the greatest impact on future economic competitiveness through technology and innovation.

The centerpiece of the American Competitiveness Initiative is the President's proposal to double, over ten years, funding for key agencies that sponsor basic research in the physical sciences and engineering that is likely to have high impact on future economic competitiveness. Certain areas within the physical sciences not only advance fundamental knowledge, but also generate new technologies that are broadly useful in society as well as in many other fields of science. ACI would make initial investments in: the National Science Foundation (NSF) - $6 billion; the Department of Energy's Office of Science (DoE SC) - $4.1 billion; and the Department of Commerce's National Institute of Standards and Technology (NIST) core programs - $535 million. The President's Budget also prioritizes the similarly high-leverage basic and applied research at the Department of Defense in 2007 by requesting $5.9 billion, $442 million (eight percent) more than last year's request.

In 2007, the ACI proposes overall funding increases for NSF, DoE Office of Science and NIST core of $910 million, or 9.3 percent. Overall annual increases for these agencies will average roughly seven percent to achieve doubling in ten years. This amounts to a total of $50 billion in new investments in high-leverage, innovation-enabling research that will underpin and complement shorter-term and mission-oriented R&D performed by other agencies and the private sector.

The ACI priority agencies each have special features that merit significant attention even in a period of budgetary constraint.

The DoE Office of Science (SC) is the nation's largest sponsor of physical science research. It supports physical science capabilities and infrastructure used by a large

number of investigators in nearly every field of science, and particularly those related to economically significant innovations (e.g. nano-, bio-, info-tech, energy, new materials and processes). Within DOE-SC, the new funding from ACI is expected to improve facilities and support approximately 2,600 new researchers.

The National Science Foundation (NSF) is the primary source of support for academic research in the physical sciences. It funds potentially transformative basic research in areas such as nanotechnology, information technology, physics, materials science, and engineering. The NSF is well-regarded for management of funding through competitive, peer-reviewed processes. The NSF funding derived from the ACI initiative is expected to support as many as 500 more research grants in 2007 and provide opportunities for upwards of 6,400 additional scientists, students, post-doctoral fellows and technicians to contribute to the innovation enterprise.

The DoC National Institute of Standards and Technology may be the highest leverage Federal research agency supporting economically significant innovations. Its world class team of scientists, recognized by three Nobel prizes during the past decade, plays a critical role in supporting standards development activities that are essential for the commercial viability of new technology. In FY 2007, NIST will seek to focus 3,900 scientists and engineers from government, industry and universities – an increase of 600 researchers over 2006 – on meeting the Nation's most urgent measurement science and standards needs to speed innovation and improve U.S competitiveness.

The proposed support for these agencies is significant, but does not comprise the largest cost in the research component of the ACI. To encourage private investment in innovation, President Bush continues to propose permanent extension of the Research and Experimentation tax credit and supports steps to modernize it to make it more effective. This tax credit expired last December, and before then was renewed a year at a time for a decade. This is a decidedly sub-optimal way to run a program intended to build long term industrial research capacity. If it were re-established in FY07, the cost in that year to the federal Treasury is estimated to be $4.6 billion, and over ten years its cost would total $86.4 billion.

Of course national competitiveness depends on more than research. The ACI identifies similar selected priority strategies in education, workforce training, and immigration practices as well. Deputy Secretary Simon described these strategies in his remarks. My objective was to describe the research part and its context, and now that I have done that, I would be glad to respond to your specific questions.

Thank you.

Education: Enhancing understanding of student learning & applying that knowledge to train teachers, develop curricula, & improve learning.

- *Advanced Placement/International Baccalaureate Program* to expand access of low-income students to AP/IB by training additional teachers.
- *Adjunct Teacher Corps* to encourage math and science professionals to teach high school.
- *Math Now for Elementary School Students* to promote research-based practices in math instruction and to prepare students for more rigorous math courses.
- *Math Now for Middle School Students* to improve math instruction for students performing below grade level.

Workforce: Offering training opportunities to 800,000 workers annually, more than tripling the number of workers trained under the current system.

- Reform workforce training by making new *Career Advancement Accounts*— self-managed accounts that individuals use to obtain training and other services—available to 800,000 workers.

Immigration: Reforming immigration laws to attract & retain high-skilled workers.

- Enhance our ability to attract and retain high-skilled workers from abroad by passing comprehensive reform that helps our growing economy.