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Thanks to AAAS for inviting me once again to address this important annual policy forum. The pace of scientific discoveries far exceeds the pace of science policy, so you would expect these annual forums to be rather repetitive and boring, especially when you hear from the same people – like the President's science advisor – year after year. This is the fifth time I have spoken in the Forum, and I will try to avoid repeating myself, although I admit I am tempted. Instead I will repeat the words of other science advisors starting with Allan Bromley. In his book about his experience as science advisor to the first President Bush, Bromley said one of his most surprising discoveries about Washington was that "it took longer to make anything happen than I could have believed possible!" This fact of Washington life means that often years go by between the emergence of challenges and effective responses to them. And yet things do happen and government can act decisively when the path forward is clear.

This year President Bush launched not one but two significant science-based initiatives in his State of the Union Message. The President's subsequent vigorous promulgation of both initiatives in forums, tours, and speeches demonstrates the seriousness with which he regards these programs as part of his domestic policy agenda. Just yesterday I accompanied the President to Tuskegee University in Alabama where he toured a NSF and DOD-sponsored nanomaterials laboratory and spoke about his initiatives in research and education. Today I want to put one of these programs, the *American Competitiveness Initiative*, in historical perspective. The other, the *Advanced Energy Initiative*, also deserves attention by this audience, but it has a smaller policy footprint. These are long term initiatives based on a conviction that science is fundamentally important for our future economic competitiveness, and for national and homeland security, the President's three highest priorities. In the larger context of post cold war science policy, the American Competitiveness Initiative – which I will refer to as "the ACI" – is part of a long evolution that began in the early 1990's and will likely continue into the next decade. Before I speak of that history, I want to recall the immediate context for this year's science budget, and remind you of the specific features of the ACI.

I know that even many policy wonks do not read the text of the annual budget proposal the President sends to Congress each year (it sits in four thick volumes on my bookshelf). But I strongly urge you to read at least the front matter in the budget – the President's Budget Message, the Overview, and the articles on special issues. These sections signal what the Administration will emphasize in the ensuing interactions with Congress to produce a final budget. I want particularly to stress the President's determination to reduce the federal budget deficit during his second term in office. In his own words: "Last year, I proposed to hold overall discretionary spending growth below the rate of inflation – and Congress delivered on that goal. Last year, I proposed that we focus our resources on defense and homeland security and cut elsewhere – and Congress delivered on that goal. … The 2007 Budget builds on these efforts. Again, I am proposing to hold overall discretionary spending below the rate of inflation and to cut spending in non-security discretionary programs below 2006 levels." In the same Message, the President also said "And my Budget includes an American Competitiveness Initiative that targets funding to advance technology, better prepare American children in math and science, develop and train a high-tech workforce, and further strengthen the environment for private-sector innovation and entrepreneurship."

The question immediately comes to mind: How are you going to fund a major initiative like this and cut spending at the same time? The ACI proposes nearly a billion dollars ($910 million) of new research funding for three specific agencies, and a commitment to double their combined budgets over 10 years – a total of $50 billion during that period. To increase incentives for industrial research, the Budget would forego $4.6 billion of tax receipts for companies that invest in research and experimentation, for a 10 year cost of $86.4 billion. The education component of the ACI would add another $380 million in FY07. The President's FY2007 budget does not increase overall non-defense discretionary budget authority, and the request for non-defense R&D budget is proposed to increase at a rate slightly less than inflation. Accommodating the ACI in a flat or declining budget is only possible by setting priorities and allocating funds differentially to the highest priority programs. The key phrase in the President's reference to this program is the "American Competitiveness Initiative that *targets* funding…" The FY07 budget for science is very clearly about priorities.

The word "prioritize" sends shivers down the backs of most science advocates. Eighteen years ago this month, toward the end of the Reagan administration, National Academy of Sciences President Frank Press gave a memorable speech at the 125th Annual Meeting of the Academy entitled *"The Dilemma of the Golden Age."* It was a shocker of a speech because Frank made concrete proposals for how to prioritize science in a time of fiscal constraint, and urged his colleagues to participate in the process. Some of you here today may recall that valiant effort. I looked up the subsequent press coverage in preparation for a speech I gave last year in a memorial symposium at Yale for Allan Bromley.

Here's Al Trivelpiece, then Executive Director of the American Association for the Advancement of Science: "Nobody asks farmers whether they want price supports for wheat rather than for cotton. Why should scientists be treated any differently and be required to choose from among several worthy projects? I think the issue for scientists should be the quality of the research." And a congressional staffer: "I hope we can forget his words and move on." And an official of the American Association of Medical Colleges: "It's a question of strategy. Why should we assume that there's a fixed pot of dollars? I prefer the idea that support for science is not fixed, at least not until we get to a level that represents a reasonable proportion of our GNP." Science advocates – which includes the major associations and professional societies – distanced themselves from Press's suggestion that the science community itself is the best place to look for guidance in establishing priorities across fields and programs.

I regard Frank's 1988 address as a key document in the history of American science policy. He prepared it at a time when scientists were chafing under the crunch of a serious budget deficit that the President and Congress were struggling to get under control. Research opportunities were outstripping growth in the non-defense federal science budget and different sectors of the science community were sniping nastily at each other. I recall it very well because at the time I was chairman of the board of Universities Research Association, then competing to build the SSC, which was the target of some of that sniping. Press explained the "dilemma" in his title as a product of the "very exuberance – in that golden age of discovery and advance. [And now I'm quoting extensively from his speech.] Our scientists are submitting in record numbers proposals of the highest quality, with enormous intellectual and material potential. We have also laid on the budget table very large and very expensive new ventures – in multiple fields from high-energy physics to molecular biology, whose time in the progress of science has arrived. The proposals – small and large – are superb in quality, but unprecedented in overall cost. And the reality is that these proposals come at a time of record budget deficits."

"There," said Frank, "is the heart of the dilemma. It is not the lack of political support for science. Political decision makers in the executive branch and Congress no longer need convincing that leadership of American science and technology is vital to our nation's future. The real political issue is what does science most urgently need to retain its strength and its excellence. The issues are funding levels and priorities."

These remain the issues today, but in the intervening years something very important has happened, and the atmosphere is different. I am not sure there ever was a time that scientists felt their sponsored funds were commensurate with their opportunities for discovery, and frustration over that gap is widespread to this day. But I no longer see the sharp-edged ill-will among different fields that worried Press nearly twenty years ago. Those were the final years of Cold War science policy and cracks had begun to appear in the framework of mutual understanding among sponsors and researchers that had supported science since Sputnik. Today we are emerging from that long transition in U.S. science policy I mentioned that began at about the time of Frank Press's 1988 address. Let me reflect for a moment on what happened during that period.

In 1989 the Berlin wall came down, and Tim Berners-Lee and colleagues at CERN launched the world wide web. Two years later historians declared the cold war officially over, and Congress began looking for a peace dividend. Within the Department of Defense, the largest sponsor of university based engineering research, science was not spared. In 1993 Congress terminated the superconducting super collider and narrowly authorized the international space station project with a margin of one vote. The ebbing tide of cold war weapons production had revealed a huge problem of environmental contamination at Department of Energy weapons facilities, and DOE science funding went flat. House Science Committee chairman George Brown admonished scientists in general, and physical scientists in particular, to seek a new post-cold war rationale for government funding of their work. Industries that had supported productive research laboratories began reducing budgets and shrinking their horizons. Some were reacting to reductions in defense spending, and others to deregulation and continued competitive pressure from Japan and the then emerging Asian "tiger economies."

Science, meanwhile, saw new horizons opening with the almost miraculous appearance of powerful tools generated by the information technology revolution. If Frank Press's late 1980's were a "golden age" for science, the 1990's revealed a platinum, or even a diamond age of discovery based on new capabilities for managing complex or data intensive systems, and especially the extraordinarily complex systems of the life sciences. The coming twenty-first century was described as the century of biology in contrast with the old century of physics. The new technologies, to be sure, were based on physical science, but it appeared to be a known and reliable physical science that had provided an inventory of capabilities "on the shelf" that the military or industry could exploit in its own new breed of shorter horizon, development-oriented, R&D laboratories. Industrial research made Moore's "law" come true during this decade, and produced the devices and systems that lured entrepreneurs and their financial backers into the dotcom bubble. These conditions tended to obscure the role of basic research in the physical sciences and depress the perception of its importance in the agencies on which the field had depended since World War II.

The obvious changes in conditions for science during the 1990's stimulated a variety of interesting policy responses. Frank Press made another important contribution as chair of an NRC committee that produced the 1995 report *"Allocating Federal Funds for Science and Technology."* This report summarized current thinking about the case for federal funding of research and added to a growing consensus that economic competitiveness was among the most important reasons for the investment of public funds in long term high risk investigations. It was an important precursor to the subsequent report prepared by Congressman Vernon Ehlers at the request of Speaker Newt Gingrich in 1998. This document, *"Unlocking Our Future: Toward a New National Science Policy"* concluded that "Because the scientific enterprise is a critical driver of the Nation's economy, investment in basic scientific research is a long-term economic imperative. To maintain our Nation's economic strength and our international competitiveness, Congress should make stable and substantial federal funding for fundamental scientific research a high priority."

Neither of these reports addressed the problem of prioritization, but by the end of the 1990's it was clear that federal funding for biomedical research was racing ahead of funding for other fields. In actions widely regarded as demonstrating the increasing dependence of life science on physical science technology, Harold Varmus, the Clinton Administration's NIH Director, funded the construction of beam lines at the Department of Energy's x-ray synchrotron light sources, and spoke eloquently of the importance of physics to biology and medicine. With the completion of the doubling of its budget over five years ending in 2003, NIH consumed roughly half the non-defense federal research funding, with NASA in second place with 15%. NASA's science budget alone has been comparable to the entire budget for NSF. DOE Office of Science budgets, which include funding for the powerful tools used to unravel the atomic structures of complex materials and bio-molecules, have remained virtually flat. Concerns about the balance of funding surfaced explicitly in a document prepared by a subcommittee of PCAST chaired by Georgia Tech president Wayne Clough in 2002. The report, *"Assessing the U.S. R&D Investment"*, stated, among other things, that "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 the previous September. Completing an Administration commitment to double the NIH budget was the highest science priority at that time, 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.

As the Bush Administration concluded its first term, further reports began to appear that linked federal programs for research and education to economic competitiveness, including two more from PCAST and one from the Council on Competitiveness in 2004. The following year, 2005, witnessed a growing wave of reports and publications with similar themes, culminating in the widely publicized report from the National Academy of Science *"Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future."* These reports contributed to a clear basis for establishing funding priorities among programs and agencies in the ACI initiative, launched in President Bush's January 2006 State of the Union message. The policy principles are *first* that funding long term, high risk research is a federal responsibility; *second* that areas of science most likely to contribute to long term economic competitiveness should receive priority; and *third* that current levels of funding for research in the physical sciences are too low in many agencies.

The American Competitiveness Initiative identifies the National Science Foundation, the Department of Energy Office of Science, the National Institute for Standards and Technology, and the Department of Defense as key agencies with major funding satisfying the three principles, and seeks to double the budgets of the first three over the next decade. The current year increase for the sum of the three is 9.3% I described other components of the ACI earlier, and will not say more about them here. My point in recounting history since Frank Press's 1988 speech is to contrast the reluctance of non-government science stakeholders at that time to discuss priorities among different fields with what can be read as a consensus within some of the same communities today that even in a time of budgetary constraint something needs to be done with the budgets in at least some areas of physical science research.

The elements of the ACI resemble some of the recommendations made in the National Academies "Gathering Storm" report, but is not intended to be a direct implementation of those recommendations, many of which overlap existing federal programs, or were expressed in a degree of generality incompatible with the kind of specificity required in a Presidential budget proposal. There is no question, however, that the "Gathering Storm" report played an important role in bringing diverse components together under the theme of economic competitiveness and created an atmosphere in which such a complex set of proposals could receive favorable treatment by Congress. The report's authors, and particularly the committee chairman Norman Augustine, deserve a great deal of credit for investing time and energy to raise awareness of the need for a set of coordinated actions to ensure the future economic competitiveness of our nation.

I am approaching the end of my talk, and I have said little about the budgets of other areas of science, or the details of how the ACI can be funded without serious negative impacts on other areas of science funding. The fact is that the FY07 cost of the ACI is dwarfed by the $2.7 billion in current year earmarks in the research budget. Earmarking has increased rapidly during the past five years, and has reached the point where it now threatens the missions of the agencies whose funds have been directed toward purposes that do not support the agency work-plans. From the point of view of transparency in government operations, earmarking at this level erodes the value of reported budget numbers for inferring agency resources. For example, the $137 million in earmarks on the $570 million NIST core budget in the current year lead to a gross exaggeration of how much money NIST actually has to satisfy its needs, particularly its physical plant requirements. The ACI request would increase the amount actually available to NIST by 24%, but because the earmarks mask the actual current amount, a comparison of the FY07 request with the FY06 appropriated suggests a *reduction* of 5.8% for NIST. This is a very serious problem. Media reporters attempting to identify "winners and losers" cannot even get the sign right on the budget changes inferred this way.

The White House Office of Management and Budget has criteria for identifying and accounting for earmarks, but those criteria are not employed by AAAS analysts, and the AAAS earmark methodology is not transparent. Unfortunately OMB does not publish earmark data, or include the effects of earmarks it in its tables. Consequently the dramatic growth of earmarks has seriously undermined the usefulness of the historically valuable OMB and AAAS analyses. Published budget numbers from either source no longer consistently reflect the actual resources available to science agencies to carry out their programs. This is not a satisfactory situation, and I urge AAAS to work with OSTP and OMB to develop a mutually comprehensible approach to the problem of taking earmarks into account in analyzing the annual science budgets.

Earmarking and prioritization are clearly related. One person's priority is another's earmark. One of the drivers for earmarking is the reluctance of individuals or institutions to participate in the merit based review procedures that are best practices in most funding agencies today. Another is the absence of funding programs for categories of expense that are deemed important even sometimes by the targeted agencies. I believe that where science stakeholders can form a consensus on priorities, the negative impact of earmarking can be greatly diminished.

I wish to thank AAAS and its members for providing not only this but many other opportunities for bringing together the disparate sectors of the nation's science community, and working to build a consensus for constructive federal science policy.