

Dear President Bush:

The Waco Forum on the U.S. Economy demonstrated your concern about our nation's economic health and we applaud your initiative in hosting this important event. As you are aware, and as was emphasized in the Waco Forum breakout session on Innovation and Technology, federal investment in science and technology is crucial to our future economic health. Your Council of Advisors on Science and Technology would like to alert you to issues regarding federal investments in science and technology that need attention as you formulate the FY04 budget.

Upon your appointment of the members of PCAST, a panel was formed to examine trends of federal funding of research and development (R&D) to determine if these were consistent with the nation's present and future needs. This panel held hearings with a range of private and public sector organizations to gain an insight into potential issues. The panel also commissioned a study by the RAND Corporation to examine trends and patterns of federal support of R&D over the past twenty-five years, and to compare U.S. federal and private sector R&D investments to other countries that compete with us in the global marketplace. (A copy of the study is enclosed with this letter.)

Based on the aforementioned activities, the PCAST panel developed a report providing its findings and recommendations for the FY04 budget and other future R&D requirements. A copy of the panel's report is enclosed, and a summary of its conclusions follows.

***Summary of Observations and Recommended Action:***

Activities emanating from R&D investments that produced new economic growth have never been higher, including increasing numbers of patents and discovery disclosures. Clearly, federal funding has enabled this, as 40% of patents cite federal research as their source. PCAST is appreciative of your personal commitment to strong investment in R&D, exemplified by the FY03 federal investment package for R&D exceeding \$100 billion for the first time in our nation's history.

However, after two decades of shifting priorities and new programs, we must now redress R&D funding patterns to guarantee that our federal investments in science and technology ensure economic strength, national security, and prosperity and health for our citizens. From our background studies and dialogue with the public and private sector, a number of concerns have emerged:

1. ***Federal R&D funding as compared to GDP continues its decline:*** Twenty years ago, federal government funding for R&D exceeded that of private industry, but today the reverse is true. R&D support from the federal government has fallen to its lowest point as a percentage of the GDP in over 25 years and is now exceeded by several other countries.

2. ***Private sector R&D investments do not sufficiently replace shrinking federal support:*** While strong support of R&D by private industry is to be commended, this source of funding cycles with business patterns and focuses on short term results by emphasizing development of existing technology rather than establishing new frontiers. Growing private investments in research do not replace the need for federal support in certain critical areas and for long-term basic research where the benefits cannot be measured in short cycles.
3. ***Inadequate federal funding for physical sciences and engineering hurts all scientific disciplines:*** PCAST's aforementioned commissioned studies have shown that from 1993 to 2000, federal support for the physical sciences and certain areas of engineering remained relatively flat, and in some instances decreased (with FY 2002 bringing only modest increases for engineering). While it makes sense that biological and life sciences support has increased given fundamental advances in this field and the heightened interest in health issues, long term breakthroughs in biological and life sciences will rely on strengthening the physical sciences and engineering as well. Further research in these areas will be important for new developments needed in the defense of our nation and in economic sectors such as semiconductors, advanced materials and energy efficiency. Testimonials from U.S. scientific societies and industry associations consistently supported this view.
4. ***Declining federal support for science and engineering students jeopardizes economic growth:*** Federal support for certain scholarships and fellowship programs, as well as other opportunities to support U.S. graduate students in science and engineering has declined significantly. Representatives from IBM stated: "97% of the Ph.D.'s who compose our nanotechnology research staff have degrees in the physical sciences.... The training of these people is largely sponsored by the federal government. There is a dramatic shortage of people with the needed skills." Over the past twenty years, some of this gap at the graduate level has been taken up by an influx of foreign students, but we are facing an over-dependence on this talent pool given the build-up of overseas technological industrial infrastructure. Testimony from both private industry and the federal sectors expressed strong concerns about the pending retirement of a generation of physical scientists and engineers with few options for replacing them.
5. ***Complex management structure prevents a focused R&D vision:*** The federal investment in R&D is derived from a wide array of federal agencies and is overseen by thirteen different committees of Congress. This complex array of entities involved in delivering the nation's R&D program results in a lack of focus for R&D, and inhibits the development and implementation of a strategic vision to ensure that the total U.S. R&D portfolio aligns with national needs and priorities. This is particularly important as your Administration and Congress work to provide support for homeland security through a wide variety of agencies. Coordination within a strategic view is needed.

6. ***International competition is stronger than ever:*** Foreign governments are investing strongly in R&D, and overseas R&D capability is growing. Our government needs to have a better system for coordinating information available to the Departments of State and Commerce and agencies like NSF in order to anticipate scientific developments from competing nations.

We provide recommendations to address these issues in the enclosed report and many are pertinent to the FY 04 Budget. Perhaps the most widely supported recommendation from both the private and public sector is to strengthen the federal government support of basic research and for the physical sciences and certain engineering fields. We are aware that many in Congress support doubling the National Science Foundation's budget. However, since NSF is not the primary funder of some important aspects of physical science and engineering, we are concerned that focusing upon this single government agency will not adequately address the issues we have identified. We also believe that the federal government must develop a suitable information resource to enable an evaluation of the balance of R&D investments towards national needs so a rational process can be applied to insure we do not fall behind in critical areas both in terms of innovations and workforce.

Based on the information we have collected and been privy to in the course of our work the key recommendations we suggest are:

***Recommendation 1.*** All evidence points to a need to improve funding levels for physical sciences and certain areas of engineering. Testimony from public and private sector representatives indicated that *"of greatest concern to the scientific community is the balance between the physical and life sciences."* Moreover, U.S. industry representatives expressly stated that *"physical sciences need sustained increases immediately,"* to support the scientific advancement, technological innovation; and human resource development required for continued economic competitiveness. However, from 1993-2002, physical sciences and engineering have received the smallest increases (or in some years, decreases) in federal research investments. **Consequently, we suggest that FY 2004 presents the appropriate opportunity to double federal research investments in physical sciences, and 4 major engineering fields (i.e., electrical, mechanical, chemical, and metallurgy & materials) from the FY 2002 levels.**

***Recommendation 2.*** A major program of fellowships should be established to attract and support the advanced graduate studies of U.S. citizens in fields of science and engineering that support critical national needs.

***Recommendation 3.*** OSTP, in cooperation with the appropriate agencies and organizations, should develop means to assess and analyze the adequacy of federal R&D investments in light of national interests, international competition, and human resource needs. While these are elaborated upon in the enclosed report, we specifically suggest the following:

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- a. Create a classification system to help assess the patterns of federal investment in R&D against its ability to meet national needs (e.g., economic impact, societal improvements, anti-terrorism, knowledge generation, human resource development, etc.).
- b. Closely monitor research investments of other nations and regularly report scientific and technological developments with recommendations to address U.S. global competitiveness.
- c. In conjunction with information collected by the U.S. government agencies, assess the adequacy of our anticipated science and engineering workforce in light of shifting national priorities.

The members of PCAST would like to express appreciation for your interest in this important topic and for allowing us this opportunity to present our findings to you. If you, or your staff, have questions or would desire more information, we will be glad to oblige.

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