1 Science Policy after September 11

John H. Marburger III

I was confirmed as the director of the White House Office of Science and Technology Policy (OSTP) last October, shortly after the terrorist attacks of September 11. My first actions were to structure OSTP to serve the President in the war against terrorism and to reach out to the science and higher education communities with a call to action. Two seasons have now passed, the war has progressed in stages both abroad and on the homeland front, and we have had time to compare the needs of antiterrorism with the other forces driving science policy. This chapter reflects on what has happened, and what a reasonable future course might be for the nation's science policy in this vulnerable world.

OSTP Today

In the Bush administration the Office of Science and Technology Policy continues to play a strong role in shaping science policy. The interagency coordinating mechanism of the National Science and Technology Council (NSTC) has proved important, not only for integrating agency actions in the war against terrorism, but also as a nucleus for crystallizing agency expertise needed for immediate response to urgent issues. OSTP gave early service to the Office of Homeland Security following the anthrax threat to the U.S. mail last fall. This action was the first in a series of new activities that will be somewhat different from the historical OSTP norm.

John H. Marburger III is director of the White House Office of Science and Technology Policy. This chapter is based on remarks delivered at the 27th Annual AAAS Colloquium on Science and Technology Policy held April 11-12, 2002, in Washington, DC.

Today OSTP manages the research and development (R&D) needs of the Office of Homeland Security through a shared senior staff member. This person has access to all the OSTP technical resources in a form of matrix management. The entire office is now organized to provide focused advice when and in the form needed by the agencies and policy offices we support. The NSTC interagency task forces, committees, and working groups continue to function as before, with less emphasis on analysis by OSTP staff and more on seeking strategic input from other organizations, including the agencies and the National Academies.

The President's Council of Advisors on Science and Technology (PCAST) has been formed and is functioning through a series of panels, one of which focuses on terrorism (others focus on energy, telecommunications, and science funding policy). I have endeavored vigorously to reconnect the Office with the Academies, the science and engineering societies, higher education, and the technically oriented private sector. We are working closely with the Office of Management and Budget (OMB) to implement the President's Management Agenda and to shape funding policies to meet the rapidly changing conditions of contemporary science.

In sum, today's OSTP is active, engaged, and effective in forming and executing the nation's science policy.

Initial Responses to the War against Terrorism

My message to the science and higher education communities last fall was first and foremost to appreciate how deeply committed the President is to winning the war against terrorism. That commitment includes mobilizing every sector of society, including science, engineering, and higher education.

Shortly after the September 11 attacks, many federal agencies launched initiatives to respond to terrorism issues and funded them with existing appropriations. The U.S. Department of Defense and the U.S. Department of State used its Technical Support Working Group to solicit, evaluate, and fund specific projects that could improve technology needed for this special kind of war. Some needs are obvious, such as increasing the capability of first responders to detect biological and chemical hazards, finding better ways to sift intelligence data from multiple sources, and developing better vaccines and therapies for biopathogens. Other needs are more strategic: defining and assessing the nature of terrorist threats and analyzing and strengthening the nation's logistical infrastructures in transportation, communication, energy distribution, food supply, and health care.

Many of us realized that these longer-term issues would require considerable thought and consultation with the nation's intellectual community. To this end, the National Academies sponsored an important meeting late in September to consider how they might organize science input to the war effort. I learned much from that event and agreed to establish an interagency task force that would take up recommendations produced by a National Academy of Sciences (NAS) committee proposed at the meeting. The committee, co-chaired by Harvard University's Lewis Branscomb, and Richard Klausner, president of the Case Institute of Health, Science and Education, will produce useful guidance by mid-summer. (See Chapter 24 in this volume.)

The institutions that produce science and technology are not only sources of solutions and advice, they are also potential targets and means of exploitation for terrorism. Universities can inadvertently provide materials, skills, and concealment for terrorist operations. They cannot ignore their responsibility to society for limiting the opportunities for such perversions of their educational and research missions. Universities need to think through these responsibilities and advise governments where to draw the line between avoiding terrorist risk and obstructing the processes of education and discovery. During the weeks following September 11, I met with higher education leadership organizations to urge them to begin dialogues on their campuses to define their positions on terrorism and to clarify where the balance must be struck in response to society's desire to protect itself. OSTP is fostering and closely monitoring the broader dialogue on these issues within the Administration.

Innovation versus Implementation in the War against Terrorism

The means for reducing the risk and consequences of terrorist incidents are, for the most part, already inherent in the scientific knowledge and technical capabilities available today. Only in a few areas would additional basic research be necessary, particularly in connection with bioterrorism. By far the greater challenge is to define the specific tasks we want technology to perform, and to deploy technology effectively throughout the diffuse and pervasive systems it is designed to protect. The deep and serious problem of homeland security is not one of science, but of implementation.

This has two consequences. First, although antiterrorism efforts contain an important R&D component, this component will not be a significant driver for science funding in general. Second, those seeking federal agency customers for specific technology products are likely to be frustrated while implementation strategy is being developed. Unlike conventional warfare, where trained personnel employ purpose-built technology in a localized and well-defined threat environment, the war against terrorism is waged across all society against the vulnerabilities of poorly defined and fragmented systems, only a few of which are owned or controlled by the federal government. Central authorities have limited means available to reduce risky practices in the private sector, and often the simplest means are unacceptably intrusive to American society.

Science-Based Science Policy

I do not mean to imply that the science role in the war against terrorism is unimportant. Nor that substantial funds will not be forthcoming to solve technical problems critical to the war effort. But science is moving forward with its own powerful dynamic, and it is producing the means for addressing many of society's difficult problems, terrorism among them. Federal support of science must be directed, first, to sustain this dynamic, and, second, to seize the opportunities it is creating for discovery and for improving the human condition. This is what I have called a "science based" science policy. It differs from what might be called an "issues based" policy because it recognizes that the discovery and creation of entirely new technologies are unlikely to emerge from mandates in service to a particular social issue.

When we say that necessity is the mother of invention, we are normally thinking of some sort of Edisonian invention that exploits existing science and ripe technology. The scope of existing science is defined by the limits of existing technology. New science requires advances in technology that are not obviously relevant to any social need. And yet each such advance has contributed substantially to social improvements. Many examples come to mind: lasers, superconductivity, and sensing and imaging technologies, to name a few. This is a familiar argument for societal support of basic science. But it is not the main point of the science-based policy that I am advocating. The main point is that science has its intrinsic needs and processes that have to be supported if the whole apparatus is to work effectively. If we ignore these needs and direct funding according to the severity of social problems we would like science to address, we tend to enrich only one part of the machinery, and we diminish our ability to address the critical problems.

Balance in Science Funding

The problem of "balance" is sometimes expressed as too little funding for the National Science Foundation (NSF) compared with the National Institutes of Health (NIH), or as too little funding for the physical sciences compared with the life sciences. I think "balance" is a misleading and even dangerous term. Perhaps the recent large increases for NIH have simply enabled health researchers to exploit the same fraction of opportunities for discovery in their field as physical scientists can in theirs under existing budgets. A strong case can be made that the discovery of the molecular basis of life processes created research opportunities vastly greater than those in the physical sciences. It is not so much the balance among fields of science that is problematical, it is the balance among the different parts of the machinery of science.

We are witnessing advances in the technical infrastructure of science that do justify large increases in certain fields, and large increases have been forthcoming in those fields. The President's proposal to complete the doubling of the NIH budget in FY 2003 is an example, but so are the priorities given to information technology and nanotechnology. I am not the first to declare the revolutionary nature of these advances. Advances in instrumentation permit us to image and control the properties of organic and inorganic materials at the atomic scale. Advances in computational and information technology enable us to manipulate atomic-level information, and to simulate the functional properties of matter based on its atomic-level description. The result is an unprecedented understanding of, and power to control, the functional properties of all matter. One product of these capabilities is the current excitement in biotechnology and its inorganic counterpart, nanotechnology. Both deserve support in proportion to the potential they hold for discovery. My impression is that the potential is greater in the vastly more complex organic domain, but huge opportunities remain to be exploited in both areas.

This oversimplified revolutionary scenario has four central components. One component includes the enabling technologies of instrumentation for atomic-scale imaging and control. Another component is the advance in computation for simulation and management of the atomic-scale information. Two other components are the discovery-oriented fields of biotechnology and nanotechnology that have been empowered by these tools. Only one component, instrumentation, is not currently identified as a priority in the federal budget. Attention to instrumentation will require analyzing the related issues of our aging and inadequate facilities. Because some of the instrumentation dwells in the domain of "big science" (for example, synchrotron X-ray sources and nuclear reactors) this issue is also related to the funding of science within the national laboratories.

If we want to achieve balance in federal science funding, we have to understand how the complicated funding process works, or fails to work, to sustain the essential tools upon which our most exciting and productive areas of science and technology depend. Once the quality of this infrastructure is ensured, we still need to address the questions of priority and adequacy of funding for the dependent fields. These questions must be answered in different ways for the two types of research that are typically described as basic and applied, but which I call discovery-oriented and issue-oriented. Priorities for issue-oriented science are driven by the nation's policy agenda. For discovery-oriented science, priorities must be consistent with the opportunity for discovery, and that is a matter for the scientific experts.

The President's Management Agenda Applied to Science

Scientists make judgments all the time about promising lines of research. Scientists choose lines to pursue, and they choose lines to drop as unproductive. That is the only way they can remain productive and relevant in their scientific careers. Some make those choices better than others. It makes sense for the world's largest sponsor of research, the U.S. government, to want to make such choices as wisely as the most productive scientists do. This, in my opinion, is how to think about the President's Management Agenda as it applies to science.

I recently shared the podium with OMB director Mitch Daniels at a National Academy workshop on this subject, and witnessed much nervousness in the audience over the prospect of evaluating basic science. Is it possible to decide rationally when to enhance or to terminate a project if we do not possess a way of measuring its success? Most program officers within the science funding agencies insist on peer reviews and peer judgments of the projects they are funding, and undoubtedly peer review will remain an essential part of evaluation. Peer reviewers apply criteria in coming to their judgments, and I think the process of evaluation would be more credible if those criteria were made explicit. That is why I support OMB's effort to introduce clearly articulated criteria into the science evaluation process. The National Science Board and the National Research Council have already produced good advice about the principles that should guide evaluation. More needs to be done to adapt this process to different parts and different ways of doing science.

The Importance of the Social Sciences

Management and evaluation are activities that can be studied objectively and improved systematically with the tools of social science. As a university president, I was always puzzled by how rarely academic managers took advantage of their own disciplines in dealing with their departments. Industry seems to have a more academic approach to management than higher education does. The social sciences in general have much more to offer on the difficult problems of our time than we are currently acknowledging in our federally funded programs. The September meeting on terrorism sponsored by the National Academies included a number of social scientists whose input provided structure and dimension to the discussion. We are not yet systematically including the social sciences in the mobilization for the war against terrorism, and this needs to be done.

I do not completely understand why we have failed in the past to develop and use the social sciences more effectively as a tool for public policy. Perhaps here too, we have not paid enough attention to the structure of the field itself and what it needs to function well. Social science also possesses the three tiers of infrastructure, discovery-oriented science, and issue-driven science. Agency programs need to reflect these more explicitly. I have no doubt that the social sciences suffer from treating issues that are so familiar as to breed contempt.

Work Force Issues

No issue deserves more attention from the social sciences than that of the future of the technology work force. Many observers have expressed concern that economic globalization is creating attractive opportunities for employment in the nations on whom we have relied for imported technical talent. We would see a catastrophic loss of technical capability if all the foreign graduate students returned to their countries of origin immediately after receiving their degrees. Already many industries are having difficulty recruiting technically trained personnel. The prospect of such a catastrophe is one motivation for a widespread interest in education, especially math and science education.

President Bush cares passionately that children acquire skills systematically throughout their education that will prepare them to participate in the 21^{st} century work force. Many factors necessary to this objective are receiving attention, from achievement testing to teacher recruitment and training. Educational research programs are being overhauled or strengthened, and initiatives are being funded to enrich science and math teaching through partnerships between schools and universities.

I believe the work force problem is more complicated than we have yet acknowledged, and will be difficult to define, measure, and resolve. The market for intellectual talent has been a global one for many years, and will continue to be in the future. How we ensure national security and national economic competitiveness in such an environment is an unanswered question. Surely we will need wise advice on this issue from the social science community.