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A Science and Technology Policy Focus for the Bush Administration

With the administration of George W. Bush commencing under especially difficult political circumstances, careful consideration of science and technology (S&T) policy could well be relegated to the "later" category for months or even years to come. Science advocates may interpret early signs of neglect as a call to lobby Congress for a proposition that already has significant bipartisan support: still larger research and development (R&D) budgets. We believe that sound stewardship of publicly funded science requires a more strategic approach.

In FY2001, the federal government will spend almost $91 billion on R&D. With anticipated increases in military R&D and proposed doublings at the National Institutes of Health (NIH) and the National Science Foundation (NSF) fueled by budget surpluses as far as the forecasts can project, next year's R&D budget could easily top $100 billion. How will President Bush assure himself and the U.S. public that this unprecedented expenditure is being put to good use?

Integrate social goals into the research mission and give the public a stronger voice in setting directions.

The traditional approach to the management and accountability of research involved relying on scientists themselves to do everything from asking the right research questions to making the connections between their research findings and marketable innovations. However, successive administrations have broken with this tradition over the past 20 years. During the Reagan era, the Bayh-Dole Act changed intellectual property law to provide monetary incentives to researchers and their institutions for engaging in commercial innovation. The elder Bush's administration more clearly articulated public questions for which scientific answers were sought, as exemplified by the U.S. Global Climate Change Research program. Strategic planning in research agencies, notably NIH, also began during this period, as did programs with more explicit social relevance such as the Advanced Technology Program (ATP). The Clinton administration created additional crosscutting initiatives in areas such as information technology and nanotechnology, implemented the Government Performance and Results Act (GPRA), expanded ATP, and pursued other programs aimed at particular goals, such as the Partnership for a New Generation of Vehicles.

Although these and similar policy innovations have been valuable, new challenges are arising as much from the successes of the earlier policies as from their short-

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comings. In particular, although R&D budgets have been increasing in large part because of high hopes for positive social outcomes, some of the basic steps necessary to facilitate an outcomes-oriented science policy have yet to be taken. We believe that the needed policies can be crafted in a fashion consistent with both the values of a Bush administration and the rigors of bipartisan politics. Our recommendations fall into two broad categories: R&D management and public accountability. They focus on a vision of intelligent and distributed stewardship of the R&D enterprise for public purposes.

R&D policy for societal outcomes

Publicly funded science is not an end in itself, but one tool among many for pursuing a variety of societal goals. More research as such is rarely a solution to any societal problem, but R&D may often combine with other policy tools to enhance the likelihood of success. Decisionmakers need to view the problems they are confronting and the tools at their disposal (including R&D) in the broadest possible context. Only then can they effectively set priorities and make the tradeoffs necessary to develop effective and comprehensive policies.

Health and health care, for example, encompass a notorious amalgam of policy considerations that include advancing the frontiers of science, ensuring access to an increasingly expensive medical system, safeguarding the workforce and the environment, promoting behavior that improves health, and dealing with the societal implications of an aging population. Effective health policy will necessarily address a portfolio of options relevant to each of these interrelated areas. Analogous arguments apply to issues as diverse as entitlement reform, education, workforce development, and foreign relations.

R&D management in the executive branch is not yet structured to achieve such integrated policymaking. Previous efforts to craft more integrative science policies focused on overcoming agency-based balkanization of R&D activities. The National Science and Technology Council (NSTC), and the Federal Coordinating Council for Science, Engineering, and Technology that preceded it, facilitated cross-agency communication and cooperation in S&T matters and coordinated research efforts on problems of national or global import, such as biotechnology and climate change. By and large, however, these efforts considered policy actions that were internal to the research enterprise. (One exception has been the interaction between the NSTC and the National Economic Council in the area of technology policy.) Thus, not only has science policy not been integrated with related areas of policy, but it has also remained marginalized in the federal government as a whole.

This marginalization is not necessarily bad for R&D funding. Increasing generosity toward NIH can be interpreted as fallout from the collapse of larger efforts to reform the health care system. But this exception proves the rule: While biomedical science flourishes, the health care delivery system remains chronically dysfunctional, and levels of public health remain disappointing compared to those of other affluent nations.

Better integration of science policy with other areas of policy is a top-down activity that must be initiated by the White House. One important step would be to appoint people with substantial knowledge and experience in R&D policy to high positions in relevant non-science agencies. In some cases, new positions may need to be created as a first step toward treating policy in a more integrated fashion. An example of such a position is the undersecretary for global affairs at the Department of State, created by President Clinton to take responsibility for many complex issues that include a scientific component, such as global environment and population. In a parallel move, President Bush should appoint people with deep understanding of relevant social policy options at high levels in the major science agencies and on advisory panels such as the National Science Board and the President's Committee of Advisors for Science and Technology.

Crosscutting mechanisms such as NSTC need to be reconfigured and reoriented so that they can consider the full portfolio of policy responses available to address a given issue. For example, although previous NSTC reports on subjects as diverse as nanotechnology and natural disaster reduction have done a reasonably good job of situating their discussions in a broader social context, their recommendations have been limited to simple calls for more research. Yet it is impossible to know what types of research are likely to be most bene-

ficial without fully considering the other types of policy approaches that are available. A Committee on Science, Technology, and Social Outcomes should be added to NSTC to coordinate the federal government's social policy missions through research and to spur attention to policy integration in NSTC as a whole. One specific task of the committee could be to build on the General Accounting Office's congressionally mandated research on peer review to examine how the R&D funding agencies incorporate social impact and other mission-related criteria into their review protocols.

Finally, recurrent calls for greater centralization of science policy—in particular the creation of a Department of Science—should be resisted, as should suggestions to create the position of technology advisor separate from the president's science advisor. The real need is for better integration of science policy with other types of social policy, rather than for greater isolation of science policy.

Public accountability

The explosion of public controversy over genetically modified foods and the publication of Bill Joy's now-famous article in *Wired* about the potential dangers of emerging nanotechnologies are recent examples of a trend with profound implications for future R&D policy. In essence, it appears that citizens in affluent societies are insisting on much greater and more direct public influence over the direction of new technologies that can transform society in major ways. Failure to engage this trend could have a profoundly chilling effect on public confidence in S&T.

Every significant federal research program should include policy evaluation research and integrated social impact research.

Mechanisms are needed that will enhance public participation in the process of technological choice, while also ensuring the integrity of the R&D process. Two types of approaches can easily be implemented. The first is to create public fora for discussing R&D policy and assessing technological choices. The second is to integrate evaluation and societal impacts research into all major federal research programs.

Public fora. A decade ago, the bipartisan Carnegie Commission on Science, Technology, and Government recommended the creation of a National Forum on Science and Technology Goals, aimed at fostering a national dialogue on R&D priorities. Little progress has been made in this direction, although it remains a useful idea. To be successful, any such process will need to ensure broad participation focused on particular regions or particular types of S&T, or both. The recently completed National Assessment on Climate Change, despite its considerable shortcomings, at least demonstrates the organizational feasibility of this sort of complex participatory process even in a large nation. At a smaller and more distributed scale, consensus conferences and citizens' panels have demonstrated the ability not only to clarify public views as a basis for policy decisions, but also to increase public understanding about particular types of innovation and to reaffirm all participants' faith in government by the people.

How might such processes play out? Consider the specific case of benign chemical syntheses and products, often called "green chemistry." As recently outlined in *Science* by Terry Collins, the promise of safer chemicals is profound. Yet few on the Hill, at the agencies, or even among the major environmental groups have heard much about benign chemical R&D. NSF has devoted no special attention to this area of research, despite a far more pressing societal rationale for it than for the well-funded initiatives in nanotechnology and information technology. Scientific societies and other traditional players have little incentive to act, despite the potential for major health, environmental, and commercial benefits. Yet chemicals in the environment are an issue of huge public concern. Public fora on chemistry R&D could allow interested people to learn about options and opportunities, to work with critical stakeholders to consider whether benign chemistry should be higher on the federal R&D agenda, and to compare the potential costs and bene-

fits of green chemistry to other uses of public R&D dollars. Far from being a threat to science, such enhanced public participation is likely to be highly beneficial.

Research on outcomes. Public fora on R&D priorities need to be supported by knowledge about how R&D programs achieve their goals and about alternative innovation paths and their potential implications for society. Current programs in the ethical, legal, and social implications (ELSI) of research attached to the Human Genome Project and the initiatives in information technology and nanotechnology are a tentative step in this direction. The ELSI programs set aside a small percentage of the research program's budget for peer-reviewed research on societal aspects of innovation. But this work is not sufficiently integrated into either the science policy process or natural science and engineering research to have much impact. To increase its public value, the concept of ELSI needs to include two additional elements: policy evaluation of R&D programs and integrated social impact research.

First, ELSI programs have generally not supported research to evaluate how well the core natural science research initiatives select and achieve social goals. Such evaluation research could build on the research agencies' own efforts at evaluation under GPRA, which have typically been competent but lackluster. Although a set-aside for evaluation would not necessarily feed directly back into the decisions that research agencies make about their programs, it would both broaden participation in research evaluation and provide useful information for the agencies, the Congress, and public groups interested in governmental accountability.

Second, we believe that ELSI-type programs must be structured to cultivate collaboration between natural scientists and social scientists on integrated social impact research. Such research would improve our ability to understand the societal context for important, rapidly advancing areas of research and to visualize the range of potential societal outcomes that could result. Prediction of specific outcomes is of course impossible, but much can be learned by developing plausible scenarios that extrapolate from rapid scientific advance to potential societal impact. By expanding on well-established foresight, mapping, and technology assessment techniques, social impact research programs would identify a range of possible innovation paths and societal changes and use this information to guide discourse in the public fora on R&D choices and to inform decisions on R&D policy. The potential value of such knowledge has been recognized at least since John R. Steelman's 1947 report *Science and Public Policy*, which recommended "that competent social scientists should work hand in hand with the natural scientists, so that problems may be solved as they arise, and so that many of them may not arise in the first instance."

Every significant federal research program should include policy evaluation research and integrated social impact research, supported at a modest proportion—5 percent should be sufficient—of the total program budget.

The structures and strictures of U.S. science policy focus so strongly on budgetary concerns that the organizational and management implications of the dynamic context for science in society receive remarkably little attention. Intelligent policymaking in complex arenas inevitably involves learning from experience, adroitly readjusting priorities as once-promising ideas play out and as new opportunities arise. But trial-and-error learning is far from easy, in part because cognitive and institutional inertia builds up around the existing ways of doing things and in part because government has not yet fully learned how to take advantage of the ability of its officials and the general public to learn.

In our view, therefore, the major science policy challenges for the new administration are to improve its ability to manage the burgeoning R&D enterprise for the public good, to enhance the capability of publicly funded R&D institutions to respond to the public context of science, and to ensure that the scores of billions of dollars in R&D funding represent an intelligent, considered, and well-evaluated investment and not the mindless pursuit of larger budgets. We believe that the two broad areas of action recommended here can provide a starting point for a politically palatable, and even potent, science policy agenda.