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Needed: Coherent Budgeting for Science and Technology

Frank Press

The intellectual function of trouble is to lead men [and women] to think.

—JOHN DEWEY

All of those concerned with science and technology in the United States—politicians who allocate federal funds, working scientists and engineers, and users of science and technology throughout the public and private sectors—are troubled about the future. Almost all affirm publicly that maintaining a leadership role for U.S. science and technology is vital to the future, but there are divergent views on how to achieve this goal. The basic science and technology policy question for the next few years is how to fit this goal into the framework of a changing world, where security has a new and broader definition than superpower confrontation, where deficit reduction is a top priority of both the Democratic and Republican parties, and where science and technology are poised for more advances than ever before.

This was the backdrop for a task from the Senate Appropriations Committee, set before the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, to address "the criteria that should be used in judging the appropriate allocation of funds to research and development activities, the appropriate balance among different types of institutions that conduct such research, and the means of assuring continued objectivity in the allocation process" (*1*). To respond, the academies assembled a panel drawn from those with extensive experience in how the government works, how science and technology progresses in universities, federal laboratories, and industry, and what nurtures successful innovation (*2*). Our report makes specific recommendations on management, budgeting, and allocation of federal funds that will maintain our nation's tradition of excellence in science and technology in times of severe budgetary pressure. It compares the different institutions that perform research and development, discusses the balance between accountability and regulation, and provides practical examples of how our suggestions could be implemented without new legislation or reorganization of the congressional committee structure. Our recommendations are supported by supplements that provide historical background and analyses of current budgets and practices. As the report (*3*) is available on the World Wide Web (*4*) and is covered elsewhere in this issue, I will highlight here some major policy questions and the principles that guided our recommendations.

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Guiding Principles

U.S. success in science and technology did not happen by chance. To their credit, our political leaders and their advisers of previous decades introduced policies, the best of which will work in the future as they have in the past. Building science and technology competency in federal departments by supporting federal laboratories and awarding grants to universities for research and training improved government performance in its missions of health, defense, economic growth, agriculture, science, space, training, and other tasks. Concomitantly, these policies created a pluralistic system of support that survived the clash of personalities and the rise and fall of budgets.

The distinctly U.S. tradition of drawing on the private sector for advice, testimony, review, and evaluation has worked particularly well for science and technology. It has resulted in healthy competition and identified the best people and projects to support. Government agencies have benefited, as has the national science and technology enterprise. Competitive merit review, especially that involving external reviewers, is key. At a time of fiscal stringency, it is even more important that it continue to be the preferred way to make science and technology allocations to universities, federal laboratories, and in general to all those involved in research and development. Naturally, special conditions do exist in highly specific mission areas where other modes of allocation are more appropriate.

The combination of training and research in U.S. universities has been a major factor in creating scientific and technical preeminence as well as in providing competent professionals to staff industries and federal laboratories. It is one of the most effective means of technology transfer, and government allocation criteria in the future should recognize this record of achievement.

Many federal laboratories have unmatched facilities and capabilities and con-

tribute in unique ways to national goals. As a result, it would be unwise to weaken them. The reasons for supporting other federal laboratories, however, are less compelling than they were in the past. Where mission requirements have diminished or when external reviewers find them less useful, then alternative resources should be redirected.

Parsing the Budget

There is no more powerful statement of government policy than budget decisions. The annual federal research and development budget is usually reported to be more than $70 billion. A substantial part of these funds is awarded by the Department of Defense to private industry for such things as testing and evaluation, setting up production lines for aircraft, and upgrading and modernization of weapons components and systems. These contracts are driven primarily by national security considerations and the interplay between military requirements and the political system. Despite their inclusion in the research and development budget, such projects do not constitute research and development as generally understood in this country or abroad. It is misleading to include them, and we set them aside from our consideration. Indeed, the Department of Defense itself considers them outside its "science and technology base." Instead, we focused on those items whose justification rests on the national need for science and technology.

Thus, our report deals with the remaining $35 to $40 billion of the federal research and development budget, the fraction that expands fundamental knowledge and creates new technologies. We defined this as the Federal Science and Technology (FS&T) budget and proposed that in the future, government support for basic and applied science and fundamental technology be presented and evaluated in terms of an FS&T budget. Just about every federal department and agency contributes to the FS&T pool either by extramural contracts and grants or by support of intramural laboratories.

The concept of an FS&T budget is not simply an alternate aggregation of numbers. It is the core of a new budgeting process that should encourage selective reductions and increases within and across agencies to reflect changing missions and performance evaluations. We need a system that continually frees funds from poorly performing or less needed projects and allocates them to better and more important ones, channeling resources to high-quality people and projects in universities, federal laboratories, or other institutions.

As science has progressed, a complex relationship has evolved between basic and applied science and technology to the point that it is more appropriate to treat them as one interrelated FS&T enterprise. Such an enterprise can be represented by the research and training programs of the science and engineering departments of our research universities and many of the activities of federally supported laboratories (the national laboratories and other intramural and extramural research and development centers). Federal laboratories (both in-house and contractor-run) account for the largest share (39%) of the FS&T budget, followed by academic institutions (31%), industry (21%), and nonprofit and other institutions (9%). With a total pool of some $35 to $40 billion, this breakdown shows that the flexibility of transfers across agencies and among performers, inherent in the FS&T budget, is a powerful tool for maintaining science and technology excellence in the United States.

Budget deficits and fiscal stringency are powerful incentives to introduce reform in the government and, in the case of science and technology, to search for a process that will maintain a leadership role for the United States. The FS&T budget represents a process for coherent decision-making at the macroallocation level. In a climate of fiscal stringency, it is the only way to fund new initiatives, pursue excellence, and maintain the overall strength of U.S. science and technology. At the microallocation level, our recommendations preserve the advantages of pluralism and the decentralized, competitive, reviewed allocation process.

Congress is zealous in guarding decisions about how it organizes itself, and members have responsibilities to constituents that go well beyond science and technology. The introduction of an FS&T budget will be just one determinant in how the committee structure of the Congress evolves. However, given efforts in the current Congress to authorize science programs more broadly rather than piece by piece, it is not at all fanciful to argue that if the president submits an FS&T budget that shows coherence and integration across agencies and sensitivity to maintaining a strong science and technology enterprise, the congressional budget, authorization, and appropriation committees would work together to review the overall budget, then disaggregate it and send it with guidance to separate subcommittees.

Most importantly, an FS&T budget should command attention in both the executive and legislative branches. In the executive branch, this would entail active management of FS&T by the Office of Management and Budget and the Office of Science and Technology Policy, working with departments and agencies that support research and development. In Congress, it will require monitoring by the Congressional Budget Office and a more coherent process within the existing committee structure of both houses. The intent is ultimately to inform the appropriation subcommittees, where most of the critical funding decisions are made, of the rationale for the overall FS&T budget, including the reasons for proposed reductions and increases. In this way, the subcommittees would act with knowledge of the impact of their separate decisions on the whole enterprise, and their individual actions would be monitored collectively throughout the budgetary process.

The Politics of Science and Technology in a Democracy

In a democracy, it is the prerogative of elected officials to promulgate policies and allocate budgets with outcomes that can weaken or strengthen U.S. science and technology. The demands on public officials for public funds are enormous. In our system, scientists and engineers enjoy an unusual degree of autonomy and provide advice on many levels, but elected officials make critical decisions. As scientists and engineers, we can and should point out the importance of science and technology to the nation's future on the basis of their contributions to about every sector of American life. If we are to be heard, our advice must be professional, credible, balanced, and not self-serving. We are proposing guidelines for management and resource allocation that, with disciplined and informed implementation, can maintain U.S. leadership in the face of severe fiscal constraints. Some would counsel us not to show where reductions can be made, because of the real possibility that the cuts will be taken though the savings would not be reallocated within the FS&T pool. This may be so, but we see no alternative but to speak truthfully about optimal allocations if the preeminent position of U.S. science and technology is to be maintained. The call for a process of budget discipline does not derive from naïve or wishful thinking but is made with full understanding of the political system and the tenor of the times.

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2. Panel members include the following: Frank Press, chair, senior fellow, Carnegie Institution of Washington; Lew Allen Jr., chairman, Charles Stark Draper Laboratory; David H. Auston, provost, Rice University; Forest Baskett, senior vice president, Silicon Graphics Computer Systems; Barry R. Bloom, professor of microbiology and immunology, Albert Einstein College of Medicine; Daniel J. Evans, chairman, Daniel J. Evans & Associates; Baruch Fischhoff, professor of social and decision sciences, Carnegie Mel-

lon University; Marye Anne Fox, vice president for research, University of Texas; Richard J. Mahoney, chairman and CEO (retired), Monsanto Company; Steven L. McKnight, research director, Tularik; Marcia K. McNutt, Griswold Professor of Geophysics, Massachusetts Institute of Technology; Paul M. Romer, professor of economics, University of California at Berkeley; Luis Sequeira, professor of plant pathology, University of Wisconsin; Harold T. Shapiro, president, Princeton University; and H. Guyford Stever, Trustee and Science Advisor.

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How Does the Texaco Case Affect Photocopying by Scientists?

The National Conference of Lawyers and Scientists*

Most people who read professional journals occasionally copy articles of special interest or significance. Does this common, everyday practice break the law? A recent case from the U.S. Court of Appeals for the Second Circuit tells us that the answer is sometimes yes and sometimes no. In this case—*American Geophysical Union* v. *Texaco, Inc.*—the court held that the photocopying of eight scholarly articles from separate issues of the same scientific journal by a research scientist was not a "fair use" under the Copyright Act (*1*). The parties politely agreed to stipulated facts describing the activities of one researcher (Chickering) chosen at random as an example through which to determine the question of fair use.

The case highlights the tension between the interests of author-scientists who want their ideas to reach the largest possible audience and their editor-publishers who profit more directly from the dissemination of those ideas. The court ruled that a commercial institution may not encourage photocopying by purchasing a small number of journals to circulate among a large number of scientists. It also held that photocopying by corporate researchers for their files is an archival use rather than a fair use, and thus it violates copyright law.

The court revised the text of its opinion twice, apparently to clarify certain points that may have been missed or misunderstood by readers of the original version (*2*). In restating its decision, the court identified two kinds of copying it explicitly did not intend to address. In the final text, the court specified that it was not deciding "the case that would arise if [the researcher] were a professor or an independent scientist engaged in copying and creating files for independent research, as opposed to being employed by an institution in the pursuit of his research on the institution's behalf" (*3*). It also noted that "[O]ur ruling does not consider photocopying for personal use by an individual. Our ruling is confined to the institutional, systematic, archival multiplication of copies revealed by the record. . ." (*4*).

Before the issuance of the last amended decision, Texaco and a steering committee of publishers agreed to settle the dispute (*5*). Under the settlement, Texaco admitted to no wrongdoing but agreed to pay a large settlement amount that includes retroactive license fees for the period 1985 through 1994. In addition, Texaco agreed to a standard licensing agreement with the Copyright Clearance Center, which collects fees from corporate entities for the right to photocopy articles from those journals whose publishers use the service (*6*).

The decision appears to affect photocopying practices that have long been accepted as a reasonable and customary practice in scientific research (*7*). Because of the particular circumstances of the case, however, many issues remain unresolved; nevertheless, the decision should cause all institutions to review their photocopy and licensing policies. Meanwhile, the victorious publishers praise the outcome as an affirmation of their intellectual property rights, and scientists fear the chilling effect the decision may have on research.

Armed with this decision, publishers may press for stricter enforcement, particularly as to corporate entities. An aggressive campaign to license large research institutions through the Copyright Clearance Center or similar mechanisms can be expected, despite the court's clear denial that it was deciding whether photocopying of articles by anyone in any setting is a fair use.

Based on *Texaco*, how should various types of for-profit, nonprofit and scholarly institutions deal with photocopying and licensing? At what point does individual copying cross the line from fair use to copyright infringement? Which institutions should be paying license fees? A few answers are found in the text of the decision. For the most part, however, the *Texaco* decision leaves many questions unresolved.

The Limited Reach of the Decision

To understand the limited reach of *Texaco*, it is important to keep in mind the narrow question the Second Circuit addressed. In the final version of its opinion, the court expressly limited its decision to (*8*):

> Whether Texaco's photocopying by 400 to 500 scientists as represented by Chickering's example, is fair use. This includes the question whether such institutional, systematic copying increases the number of copies available to scientists while avoiding the necessity of paying for license fees or for additional subscriptions. We do not deal with the question of copying by an individual, for personal use in research or otherwise (not for resale) . . . .

The *Texaco* decision strongly suggests that any large, for-profit corporation in which employees systematically make copies of journal articles for archival purposes probably violates copyright. Thus, the U.S. Court of Appeals appears to have lowered the threshold at which other courts may find copyright violations, at least within the context of for-profit entities. Any for-profit institution whose copying practices resemble those of Texaco would be well advised to pay license fees or make other arrangements with journal publishers. But what if the copies are made for convenience and not archival purposes? What if the copying is isolated and not systematic? What if the institution is nonprofit? In discussing an important factor for determining fair use—the purpose and character of the use—the court characterized Chickering's use as archival because the copying was "done for the primary purpose of providing numerous Texaco scientists (for whom Chickering served as an example) each with his or her own personal copy of each article without Texaco's having to purchase another original journal" (*9*). The court noted, however (*10*):

> [W]e do not mean to suggest that no instance of archival copying would be fair use, but [this] factor tilts against Texaco in this case because the making of copies to be placed on the shelf in

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