14. W. S. Reznikoff, C. A. Michels, T. G. Cooper, A. E. Silverstone, B. Magasanik, *J. Bacteriol.* **117**, 1231 (1974); D. Mitchell, W. S. Reznikoff, J. Beckwith, in press.
15. W. S. Reznikoff, R. B. Winter, C. K. Hurley, *Proc. Natl. Acad. Sci. U.S.A.* **71**, 2314 (1974).
16. A. Gierer, *Nature (Lond.)* **212**, 1480 (1966).
17. J. C. Wang, M. D. Barkley, S. Bourgeois, *ibid.* **251**, 247 (1974).
18. J. H. Miller, K. Ippen, J. G. Scaife, J. R. Beckwith, *J. Mol. Biol.* **38**, 413 (1968); R. Arditti, T. Grodzicker, J. Beckwith, *J. Bacteriol.* **114**, 652 (1973); J. D. Hopkins, *J. Mol. Biol.* **87**, 715 (1974).
19. J. Beckwith, T. Grodzicker, R. R. Arditti, *J. Mol. Biol.* **69**, 155 (1972).
20. Deletion X8630 is one of several *tonB-lacI-lac*$^+$ deletions whose isolation is described by J. H. Miller, W. S. Reznikoff, A. E. Silverstone, K. Ippen, E. R. Signer, J. R. Beckwith [*J. Bacteriol.* **104**, 1273 (1970)].
21. A. D. Riggs, G. Reiness, G. Zubay, *Proc. Natl. Acad. Sci. U.S.A.* **68**, 1222 (1971).
22. J. Majors, personal communication.
23. More extensive repeats are discernible in this interval if A·G and C·T degeneracies are allowed; that is, the LAC sequence purCTTTApyrpurCTTpyr is present as an overlapping repeat (pyr, pyrimidine; pur, purine).
24. H. Schäller, C. Gray, K. Herrmann, *Proc. Natl. Acad. Sci. U.S.A.*, in press.
25. W. Zillig, K. Zechel, D. Rabussay, M. Schackner, V. Sethi, P. Palm, A. Heil, W. Seifert, *Cold Spring Harbor Symp. Quant. Biol.* **35**, 47 (1970); F. R. Blattner, J. E. Dahlberg, J. K. Boettiger, M. Fiandt, W. Szybalski, *Nat. New Biol.* **237**, 232 (1972); J. Saucier and J. Wang, *ibid.* **239**, 167 (1972).
26. M. Chamberlin, *Annu. Rev. Biochem.* **43**, 721 (1974).
27. J. Burd, R. Wartell, R. D. Wells, *J. Biol. Chem.*, in press. Binding of actinomycin D to the model polymer $d(C_{15}A_{15}) \cdot d(T_{15}G_{15})$ raises the melting temperature of the A·T sequences. Burd *et al.* have termed the transmitted affect of binding "telestability" and have independently suggested that such interactions could explain the mode of action of CAP in stimulating lac expression. They also suggest that this effect might explain the phenotypes of certain lac promoter mutations.
28. J. Gralla, personal communication.
29. D. Pribnow, personal communication.
30. T. Pinkerton, G. Paddock, J. Abelson, *J. Biol. Chem.* **248**, 6348 (1973).
31. The exact location of the start site shows a slight ambiguity since occasionally the lac message starts with the preceding G (*10*, *22*).
32. We thank F. Blattner and J. Dahlberg for suggestions and materials; W. Atkinson for computer programming; R. Burgess for RNA polymerase; C. Hurley, P. Johnson, D. MacDonald, A. Otsuka, and K. Thornton for technical assistance; J. Beckwith, S. Bourgeois, T. Grodzicker, J. Hopkins, J. Miller, and D. Mitchell for bacterial strains; and J. Burd, W. Gilbert, J. Gralla, D. Pribnow, J. Majors, H. Schäller, and R. Wells for permission to quote their results prior to publication. This work was supported by NIH grants 1-R01-GM-19670 and CA 10984, by NSF grant GB-20462, by the Cancer Research Coordinating Committee of the University of California, and by the Wisconsin Alumni Research Foundation. J.A. was supported by a faculty research award from the American Cancer Society. W.S.R. was supported by a career development award 5-K04-GM-30970 from NIH and W.M.B. was supported by NIH training grant GM-00236.

Science Advice in the White House? Continuation of a Debate

Eugene B. Skolnikoff and Harvey Brooks

A new debate over the purpose and structure of a science advisory apparatus in the White House is now well under way, spurred by the apparent interest of President Ford in some kind of structural change. An important article by G. B. Kistiakowsky in *Science* in April 1974, the report by a select committee of the National Academy of Sciences (NAS) chaired by James R. Killian, the recent hearings of the House Committee on Science and Astronautics, S. 32 sponsored by Senator Kennedy (D–Mass.) and passed by the Senate, and assorted items in the pages of this and other journals have contributed to the debate (*1*). So far, the consensus seems to favor creation of a modified Office of Science and Technology—a three-member Council for Science and Technology patterned after the Council of Economic Advisers and the Council on Environmental Quality. The existing arrangement in which the director of the National Science Foundation (NSF) also serves as science adviser to the President is given short shrift, as are other possibilities.

We agree with the proposal for a three-member Council for Science and Technology (CST); but we believe the detailed structure is much less important than the nature of the tasks to be performed and the arguments that justify such a council in the first place. The case for the CST has not been made adequately, in our view, by any of the contributors to the debate, although the Kistiakowsky article comes closest. The NAS study, the most widely quoted, fails to deal with the politics behind the issue or to examine the real and critically important lessons of the rise and fall of the President's Science Advisory Committee (PSAC) and the Office of Science and Technology (OST). It is essential that we be clearer about the possibilities and limitations of a science office at the White House level if a successful and stable office is to be achieved.

For analytical purposes it is useful to divide the functions that must be performed into (i) the science advisory function for the President, and (ii) the science policy function for the Executive branch. Although they overlap, there is a difference between an intimate advisory role for the President, and a broader science and technology "management" or policy role for the government as a whole. The first involves a close personal association with the President in a White House staff relationship, bringing to his attention scientific and technological aspects of policy issues under consideration, and representing him in dealings with other parts of the government. The second implies all the problems of allocation of resources for science and technology, reconciliation and integration of multiagency programs, evaluation of the quality of agency R & D programs, early warning of technology-related problems, and concern for the health of the R & D community, for science education, and for other policy issues directly related to or bearing on science and technology.

In practice a sharp demarcation between these two functions is not possible; there is a difference of emphasis only. The PSAC and later the OST clearly felt responsible for both. Yet one of the two could be represented at the White House level without the other, depending on a given President's preferences. In fact, we would argue

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that it was the statutory identification of, and, indeed, confusion between the two functions, and OST's persistence in attempting to fill both simultaneously when the advisory function was withering on the vine, that contributed to the ultimate demise of the office. The science policy function, if justifiable at the presidential level, can give an institution permanence; the advisory function will always depend on the variations of presidential style and politics.

Science Advisory Function for the President

There is presumably no reason to debate at this time the need for scientific and technological advice at the presidential level. The significance of the various technology-rich security, energy, environmental, and other issues that a president personally must face are obvious. Equally evident is his difficulty in obtaining technical judgments that he can grasp and then interpret in relation to the political and other considerations which he must also weigh in these issues.

But agreeing that there is such a need does not determine how that need should be met. This science advisory function could be performed within the National Security Council (NSC) and domestic council structures or as part of Office of Management and Budget (OMB), through a single person with a small staff in the White House, or through a CST. Whatever mechanism is established, it will have to take into account that every President has his own working style and pattern of White House relationships, and that these cannot be determined by others. The primary political lesson from the OST experience is that it is not possible to legislate an intimate advisory function for the President. In fact, institutions at that level with political power independent of the President almost certainly will be ignored and probably will be destroyed.

Ultimately the President's test of a successful science advisory apparatus is whether it helps him politically while still preserving its own intellectual integrity and unique perspective. It can help him by suggesting new policy or program initiatives for which he can take personal credit or by being foresighted about science and technology issues that are likely to cause controversy. The science adviser can keep the President from allowing problems to fester until they can be used by critics and from putting the President's political prestige behind projects and policies that are likely to fail eventually because they are unsound scientifically. In many cases the science adviser can retain credibility not by directly opposing presidential views on policy grounds, but rather by clearly and forcefully warning the President of the political consequences before and not after he embarks on certain courses. Or, the adviser can help provide a scientific evaluation and justification for initiatives a President might desire to take on political grounds, or make sure after the fact that the implementation of such initiatives is technically sound and not undermined by the biases of the departments and agencies. The PSAC played that role with respect to the early bilateral science agreements with Japan and the Soviet Union and many aspects of the space program, and it could, if it still existed, be continuing that role in relation to Project Independence and to the growing number of bilateral agreements for science cooperation.

The most difficult problem is in the national security area. Here the President's need for scientific and technological advice independent of the Defense Department and other security-related agencies is crucial. In fact, the primary contributions of PSAC were not only in advice to the President, but often in direct relations with the Pentagon. But the special assistants for National Security Affairs since 1960 were never fully comfortable with a role for PSAC in this area and increasingly tended to reduce PSAC influence. Over time, PSAC's influence in the security area was far less than it was in the late 1950's and early 1960's, and far less than was in fact needed.

There may, however, be alternatives. If there is no science advisory office close to the President, another possibility for security issues could be the creation of a science advisory staff within NSC, although such a staff would be hard to establish with adequate size and continuity. However, if there were a science advisory office, joint staff assignments between NSC and the science office, as developed between OST and NSC for a time, could be a valuable coupling. One way or the other, a science advisory function in the security area for the President is critical.

In sum, for the presidential advisory function we believe that some mechanism is essential but that it must be established anew by each President. It can take many different forms; but if a stable, politically savvy, high-quality staff in the Executive Office of the President was already performing the science policy function, and, therefore, was ready at hand, it could be the likely candidate for a personal advisory role. But such a staff must have a continuing reliable foundation if it is to be "ready at hand" for each President, and it must be competent to carry out both functions, recognizing that they can compete as well as be mutually supportive.

Science Policy Function for the Executive Branch

One component of the role for which PSAC and later OST were created was to oversee a burgeoning federal responsibility for science and technology. The situation today is not basically different from what it was in the late 1950's and early 1960's as far as R & D is concerned. The federal budget for R & D is larger, though not in relation to the gross national product. R & D allocations continue to be made annually at department levels based on the missions of those departments. Scientific and technological competence is much more widespread throughout government, but science and technology are also more intimate parts of all policy issues than ever before.

However, there are some other changes as well. In contrast to defense and space programs, technical programs in support of the solution of social problems tend to conform much less easily to the functional organization of the Legislative and Executive branches. Whereas high technology programs in defense and space are largely concerned with means to serve agreed goals, technical programs to solve social problems more often are concerned with alternative goals as well as means to achieve goals. These programs characteristically cut across agency objectives and capabilities in ways that make overall planning both more essential and more difficult. The fact that political, economic, and other nontechnical or semitechnical considerations are much more prominent in the key decisions regarding future directions in such policy areas as energy, transporta-

tion, environmental planning, health care delivery, and food supply, adds to the need and difficulty of overall planning.

As the pace of both social change and expectations accelerate, planning for future needs, assuring timely investments in specific technologies, and avoiding premature commitment to the wrong large-scale systems loom as much greater imperatives than even 15 years ago. An early warning capability to foresee problems requiring R & D investment well before the problems require crisis treatment thus takes on immensely important proportions.

The growing complexity and resulting inertia of government make it increasingly critical that policies once decided have adequate oversight and are then followed through. For all the well-understood reasons, the political forces at work in multiagency issues, aided and abetted by the pattern of organization and influence of Congress, tend to dilute or divert changes of policy direction unless continuous oversight is maintained.

The slow but hopefully real signs of change in the Congress, where there is a developing capability to examine scientifically and technologically related issues on a broader base than in the existing committee structure, calls, in turn, for a matching capability in the Executive branch. The Office of Technology Assessment and the new congressional budget office could become powerful factors in challenging Executive branch policies or the lack of them. Or, the argument can equally be turned the other way: A strong science policy focus in the Executive branch would contribute significantly toward bringing forth a competent congressional response, thus strengthening the Congress' capabilities in science and technology, and in turn assuring a more intelligent and relevant public debate on such issues.

Perhaps there is no area of government activity where the conflict between immediate needs and long-range capabilities for problem-solving is more evident than in the application of science and technology to immediate needs. The growing pressure for visible, measurable, usually short-term payoffs of research at the expense of long-range research, while not confined to one Administration, may, in fact, require continuous vigilance and political mobilization on the part of leaders of the scientific community if long-term injury to the national scientific potential is to be avoided.

But even for this function, it is not self-evident that a new office is needed. At least some of the needs mentioned above, in particular those involving budgetary and related allocation questions, could fall quite naturally within the purview of the OMB. Others, such as "early warning," do not necessarily have to be carried out above the level of the departments and agencies. In fact, some needs, such as concern for the health of the scientific and technology community, may require advocacy roles that conflict with other functions in which a more disinterested approach is necessary.

A strong argument, moreover, could be made for an effort to build the right kind of scientific and technological competence within the OMB and the Domestic Council and to strengthen the NSF Science and Technology Policy Office to perform long-range analyses. Such a solution would avoid creating a new Executive Office agency and would more importantly bypass some of the inevitable problems of an office at the White House level having both management and advocacy roles.

On balance, however, we believe the case is stronger for re-creating an instrument in the Executive Office of the President with science policy functions as we have outlined them.

1) Over many years OMB has never shown a willingness or ability to build the kind of staff able to oversee with substantial technical insight the science and technology activities of the government. This is particularly evident with regard to defense programs, on which OMB has had little influence overall. Even if OMB attempted to build an adequate in-house technology competence, such an office would likely be so tied to the annual budget cycle and so sensitive to pressures to limit expenditures that it would be difficult to carry out those functions requiring a different time perspective. In addition, multi-agency program initiation and oversight, usually involving other issues beyond budgetary matters, would be exceedingly difficult to carry out reasonably from an office with predominantly budgetary concerns.

2) Whatever value the science policy office in NSF can have, and that can be substantial, it simply cannot be expected to perform politically difficult management functions that involve influencing or controlling programs of large rival departments. If nothing else, the key to flushing out problems and evaluating progress and potential is access to detailed, accurate information from the working level. As difficult as it is for a White House office to get accurate information when agencies do not want to give it, it would be impossible for NSF, which must work largely through approved channels.

3) The foreign policy role that is needed, discussed below, cannot be carried out at all adequately from either OMB or NSF.

4) A strong focal point in Congress requires a strong focal point in the Executive Office where all the threads can be gathered together.

5) Our last argument for a strong science policy office is simply our hope that such an office would in fact also be used as a close presidential adviser. It cannot be used, however, if it does not exist.

Thus, we believe an Executive Office mechanism for science policy is the best solution, although there are important problems that must be faced. The precise structure is not as important as its mandate, though we believe a three-man office or council makes sense as a way of dividing what will quickly become difficult burdens. It should be a council serving at the pleasure of the President, to insure his acceptance of it as part of his Administration, though the staff might well be a continuing one.

To make it possible for such a council to serve in a presidential advisory role, the science policy function must be distinguished from operational responsibility for specific interagency programs. The OST got into difficulties when its operational responsibilities conflicted with its advisory responsibilities and it found itself in the position of being both the promoter and critic of particular scientific programs in such areas as atmospheric sciences, oceanography, and water resources. Even with the most conscientious efforts to be objective, it was seen by operating agencies with different priorities, and by congressional committees, as having a particular program axe to grind; and this tended to erode its credibility as a disinterested advisory body even in areas where no such conflict of interest existed.

The initiative of the Executive Office will sometimes be needed to get important new programs off the ground, but any such initiative should be under-

taken with the clear understanding that operational responsibility would be transferred as soon as possible to existing agencies or new interagency mechanisms separate from the Executive Office. The role of PSAC in the creation of the National Aeronautics and Space Administration (NASA) out of the old National Advisory Committee on Aeronautics (NACA) is the kind of proper transitional responsibility we have in mind. Except temporarily, an Executive Office agency should not be placed in the position of having to promote a new technical program while at the same time being expected to balance it in an objective way against existing programs within agencies.

Objectivity of Scientists and Engineers

The very intimate relation of scientific and technological factors with broader aspects of policy issues means that scientific and technological inputs alone are far from enough if a council is to do its job adequately, a point that the NAS study mentions but does not demonstrate that it fully appreciates. In fact, the NAS study points out how large is the group of qualified scientists and engineers who can "provide counsel with respect to major societal matters that entail a strong scientific and technological component." However, the study indicates only that they should have broad experience in administrative and political tasks within their professions and personal qualities of "intelligence, wisdom, judgment, humanity and perspective." These qualities are so obviously desirable for anybody in a high position that they are hardly helpful criteria for the selection of scientists.

The qualities required have to do more with the ability to understand the political and economic setting sufficiently so that the scientific and technological factors may be seen as intimate interacting parts. In other words, the individuals should be able to translate policy concerns into questions about relevant science and technology; should be able to relate scientific and technological uncertainties to political choices; should understand the impact of policy objectives on technological development; and should be able and willing to enter the political and institutional competition inherent in the making of policy. But all these abilities require a sophistication in the nontechnical aspects of policy issues, as well as in the scientific and technological components. These are not widespread talents, nor are they easily acquired. The subset of qualified individuals is not defined by the number of scientists and engineers in management posts in their professions, as the NAS report states. Nor, we might add, is the subset made up only of scientists and engineers. The need for such abilities is demonstrated by the PSAC and OST studies outside the national security area, studies that were both prescient and ineffective.

For almost every crisis problem of the 1970's there is a PSAC or OST report which foresaw the problem and recommended a research program to do something about it. But in almost every case OST failed to get the attention of top policy-makers sufficiently to raise the issue to the necessary level of political visibility to generate concern and action. Authoritative, scholarly reports were produced, but little else. And the subject tended to die after a little flurry of attention.

Why? Basic researchers and academic scientists have a professional bias which assumes that if only the facts and understanding are made available, society will automatically appreciate their implications and act accordingly. The PSAC has by-and-large represented this orientation, and most of its reports failed to translate their analyses sufficiently for politicians to understand their significance in their own terms. The energy report did not say how the energy supply situation might reflect on the American economy and our foreign policy goals. The food report did not demonstrate that the world food problem might produce tangible political and economic effects that could embarrass an administration. The civilian technology report did not explain adequately how a lag in the development of civilian technology might ultimately contribute toward undermining the U.S. international trade position and consequently the position of the dollar as a reserve currency. These failures were not merely failures of political skill and salesmanship; they represented deficiencies in analysis of the problems involved, because the understanding of political and economic implications was considered to be outside PSAC competence, in the province of the politicians. There remained a deep intellectual gulf between the scientific analysis and the policy pressures and options faced, or soon to be faced, by decision-makers. This was a real intellectual gulf, not just political naiveté.

Of course, a difficult dilemma is faced here. The more the political implications of scientific advice are explicitly dealt with, the more it is necessary to depart from the domain of "objective" and "value free" analysis, which has helped to make scientific advice acceptable to politicians and the public in the first place. But there is a fair amount of mythology on this question of objectivity and value-free analysis on the part of scientists and engineers that needs to be straightened out.

There is no question that in their professional capacities scientists and engineers must live by an ethic of objectivity. Whatever their intent, however, scientists and engineers are subject, on policy issues, to biases and prejudices just as are others. The issues on which advice is sought at the higher levels of government are almost always ones in which technical uncertainty is high, important evidence is lacking, and associated nontechnical issues are contentious and critical. Judgment on both technical and nontechnical issues and on their interaction is thus required; a logically reasoned single answer is not possible. Judgment is necessarily affected by biases, policy preferences, ignorance, differing estimates of the nontechnical factors, and other vagaries. There is nothing wrong with this; it is unavoidable.

But it must be recognized, contrary to the impression left by the NAS report, that a council of scientists cannot provide purely "objective" analyses. What such a council will do is give another view, a different and fresh perspective; and, on issues not involving its own institutional loyalties, it may in fact be a more disinterested view than that of the agencies of government whose bureaucratic interests are more directly involved. But its objectivity is only relative, and very much affected by the nature and implications of the particular question that is being considered.

On the other hand, we must be careful here not to imply a simple politicization of the science advisory function. There is a difference between purely political advice and the kind of analysis performed with a clear attempt to attain as much objectivity as possible. In scientific and technological matters this is often easier than in other fields because at least some part of every prob-

lem is factual and verifiable. Moreover, scientists and engineers often carry influence to the extent that they are seen to be objective and outside the normal policy battles. These are valuable attributes that deserve to be preserved and utilized, for increasingly society requires institutions that are seen to be in some sense disinterested and able to be relied upon for independent judgments.

Our point is that this is a matter of degree, and that it should not be assumed that the advice of scientists and engineers on policy questions is totally disinterested. Nor should it be accepted that science advice can be no more "objective" than any other personal or political input. There is a value to striving for objectivity; we just must recognize that it has its limitations, and that the greater the range of uncertainty in the technical answers, the wider the door for entry of differing policy perspectives.

The NAS committee itself demonstrates this problem. Its conclusions were surely influenced by the fact that a large majority of the committee members and its executive assistant had been heavily involved in PSAC in the past, yet this fact is never mentioned. It is also curious that the role of science and technology in society is referred to almost exclusively in positive terms. The widespread public concerns over the negative effects of technology are only hinted at, and never addressed directly.

On the other side of the same coin, it must be recognized that a CST will be assumed by others to be an advocate, whether intended or not. Moreover, it must and should be concerned with the health of science, which necessarily involves some advocacy. There is no avoiding this conflict between advocacy and objectivity; it can, in fact, be dealt with in practice, but it must be recognized if there is to be any chance of dealing with it.

The foregoing discussion suggests that advice about science and technology must somehow be better integrated into political and social thinking about the future of the country. There is a need for "interpreters" who think more like politicians and policy-makers, but are still not bound by the exigencies of short-term political considerations. The need is for people who can talk to both the scientists and the politicians continuously, but not feel themselves fully identified with either.

In the light of this discussion, the makeup of the three-man council is particularly difficult to define. Certainly, all or most of the members should have the confidence of the scientific and technological communities in the sense that they will insure the highest professional standards. But, the council members must not be simply representatives of the communities; their scientific credentials are a necessary but not sufficient condition for effectiveness in the advisory function. Perhaps one way to proceed would be for the President to seek lists of candidates from recognized bodies in the scientific and engineering communities, such as the NAS and the National Academy of Engineering (NAE), from among which he would hope to choose. He should not be bound by such nominations, but they would set a standard to help avoid the danger of appointing those whose views are regarded as extreme or eccentric among scientists and engineers, or those who are politically active but of low scientific quality of judgment.

It is also entirely reasonable that one or more members of the council not be scientists. Rather, they could come from a growing group who are sensitive to scientific and technological issues and have the experience and ability to relate these to the political environment and to political choices. Presumably, many on the staff of the council would also have these characteristics.

Public Access

One of the more difficult questions, much less pertinent in the early days of PSAC and OST than today, is the degree to which a science office at the White House level should be accessible to public scrutiny of its meetings and reports. In part, this is a matter of law as a result of the Federal Advisory Committee Act and the Freedom of Information Acts as well as the precedents set by the turmoil of Watergate. In part, too, it is a matter of policy as a result of the need for an electorate better informed on the implications and opportunities of science and technology.

Our judgment on this issue follows the distinction made between a science policy function for the Executive branch and the science advisory function for the President. The science policy function can more readily be and is now required to be a relatively open process with some public access to committee meetings, published reports, and the like. Without destroying the office's effectiveness and access to information it should not be too difficult to devise a pattern allowing considerable openness on some issues, or on some parts of the process.

This openness would also be particularly helpful in making it possible to obtain more inputs from nongovernmental sources, including more of the scientific "grass roots."

With the detached air of those not bearing the responsibility, we also heartily endorse the proposal often made that a science policy office should be required to issue an annual report on some aspects of the state of science and technology in the United States. That could be a powerful educational and policy tool, useful for the Congress and the public, as well as a vehicle for forming Administration science policy.

The presidential advisory function, however, cannot be open to any appreciable extent. Aside from problems of classified material, a president requires confidentiality of his advisers on substantive policy issues. When policy is being formulated, the President should consider the widest possible variety of options. Early disclosure can alert powerful lobbies to seek to block consideration of options adverse to their perceived interests. Premature publicity regarding options subsequently rejected can embarrass the President and ensure that he will not consult his advisers until his own mind is fairly well made up. The last thing that endears advisers to a President is their adding to his political problems rather than helping to solve them.

This dichotomy does serve to create a possible barrier to a President's willingness to use as his personal staff advisers a council whose members operate with some public access to their deliberations. The problem should be manageable, however, with some clear rules of procedure. As with so many problems, this one can probably be dealt with effectively if it is recognized from the outset.

Relations with the Scientific Community

The relations between a CST and the scientific and engineering community in

the country are important and not at all likely to be simple. The question is whether it is or seems to be representative of scientific and technological interests or whether it is in some sense independent and objective. As we have already said, the problem of objectivity and advocacy is unavoidable, but it must be acknowledged and plans should be made to avoid its pitfalls. With regard to relations with the community at large, a CST would have to go to considerable lengths and exercise unusual discipline to avoid responding directly to lobbying by scientists and their professional organizations. The NSF can much more appropriately perform that lobbying role, and with the existence of a council it would have an understanding ear at court.

Even in its relations with NSF, a CST should not simply treat NSF's proposals and budgets more sympathetically than others, but as critically as it treats other agencies. A council's influence with other White House bodies is likely to erode, as did OST's, if it is perceived, even unjustly, to be insufficiently critical with its "own" constituency.

The reorganized NAS and NAE and the Institute of Medicine (IOM) present a special situation. Their large and strong capability both for mobilizing scientific competence from outside the government for analysis of many public issues or for evaluating the state-of-the-art in fields of science and technology is too valuable not to be used heavily by a CST. But the work inevitably carries the tag of coming from the heart of the science "establishment" and does in fact tend to reflect the implicit biases of this group of scientists and engineers.

The CST's job, then, would be to use NAS, NAE, and IOM, but to recognize that inputs from those organizations are only one of those it must have. In any case, as we discussed earlier, the CST must be so acutely aware of the need to present its findings in terms useful to its immediate clients that it should never be in a position of uncritically adopting outside reports as its own.

International Dimension

When it comes to attempting to define the role of a White House science office in the nonmilitary aspects of U.S. foreign policy, and particularly with the Department of State, most observers are reduced to vague handwaving. The reasons are not hard to find.

The Department of State itself has never been able to build the level of internal science capability to which it has repeatedly committed itself. Its present science office is the strongest it has ever had, but we believe that even the last director, Herman Pollack, would agree that it needs substantial changes. With weak internal competence in State in the past, it was difficult for PSAC to relate effectively and usefully to the department.

A more fundamental reason for weakness in the Department of State is the fact that many of the foreign policy issues with important technological aspects—now covering an increasingly wider portion of foreign affairs—are issues in which other agencies of government have a large and often commanding voice. Space, atomic energy, food, environment, oceans, to say nothing of defense, are all subjects in which the technical agencies of government have money, large staffs, and dominant control of complex esoteric information. The Department of State has neither money nor large staffs in these areas nor great competence in the individual technologies. And yet it is expected to cover all issues while each of the other agencies can focus on its area of primary concern.

The situation is ripe for change. A new office, headed by an Assistant Secretary of State, has been created to be responsible for scientific, ocean, and environmental affairs. Dixy Lee Ray, recently head of the Atomic Energy Commission (AEC) has been named as the first incumbent. The office will have greater prestige within the department, and perhaps more personnel. A new advisory committee on Science and Foreign Affairs had earlier been established to help the Secretary of State; it now could be in a position to assist the new Assistant Secretary to tap outside expertise in order to avoid complete dependence on the technical agencies.

Thus, one possible answer with regard to CST's role in foreign policy is to wait until State is itself stronger so that there can be more effective interaction. But there are other factors that must be taken into consideration.

When one looks at the entire federal R & D budget, a curious fact emerges. A substantial portion of that budget, well more than half, is committed to missions which have strong foreign policy motivations and repercussions: primarily the Department of Defense, some of the AEC, and some of NASA. A good portion of the rest goes for work in subjects that will affect foreign policy quite directly: agriculture, energy, oceanography, foreign trade, and population to mention just a few.

However, given this strong foreign policy motivation for federal R & D, the Department of State, the one department of government most concerned with foreign policy below the President, has essentially no voice in the allocation of those R & D resources. Instead, other departments and agencies rely on their own interpretation of what serves foreign policy goals in setting their R & D objectives. The President and Executive Office agencies (NSC and OMB) oversee the process, but only in the most general terms. The Department of State merely has to cope with the consequences.

Perhaps the Department of State never can do much to become a real participant in R & D allocations, although we believe the attempt has never seriously been made. If it were undertaken, a CST at the White House level could be a powerful, even an essential ally.

Quite apart from what the Department of State does, however, it seems clear that a CST in its science policy role must attempt to fill this important gap. It must make a concerted, self-conscious effort, more than PSAC ever attempted, to keep foreign policy concerns constantly before it in all the subjects with which it deals. This will have implications for membership, for staffing, and for the agenda; but it is an important requirement not now being carried out adequately anywhere in government. There is no other candidate agency within the Executive Office of the President, and even if State were better able to participate, it would need help.

Last, it is well to point out that bilateral science and technology agreements are becoming a more frequently used tool of presidential diplomacy. While it would be a mistake for a White House science policy office to have operating responsibility for those agreements, there certainly needs to be a capability for overseeing the agreements and their execution at a level above that of the departments. The NSF director, in his capacity as presidential science adviser, is performing that function now; but operational responsibilities are scattered among sev-

eral departments and agencies, and in practice there is relatively little policy coordination. The overview of OST is now sorely missed by those most heavily involved in carrying out the agreements.

Other Issues

Many other issues deserve detailed attention, but these cannot be covered in a brief article. Let us mention just three: (i) How should the social sciences be represented, if at all? We believe it is essential that the social sciences be included in the science policy mandate of CST, although the means for doing so merit more discussion. (The NAS report does not mention the social sciences at all.) (ii) How is experience in other countries in their science policy structure relevant and useful for the United States? For example, is there merit in adopting the French practice of allocating a specific budget to the science policy office to be used for seeding new research areas or reorienting old ones? How has that actually worked in practice? To what extent is it applicable in the U.S. context? (iii) What of the recurring proposal for a cabinet-level Department of Science and Technology? We have not discussed this alternative in part because it does not seem to us to be either viable or desirable, but in any case because a new cabinet department would not solve the problem of Presidential advice or Executive Office oversight. If such a department were created, it certainly would be a powerful force in scientific and technological affairs, but the broader technology-related policy issues and the need for integration of programs across departments and agencies would remain. The actors would be different, but the essential factors similar.

Summary

Thus, we are skeptical of the commonly stated arguments for re-creation of a science office at the White House, but are ultimately convinced that such an office is justified. A three-man CST is a reasonable proposal, although the detailed structure is less critical than the mandate given to the office, and the general understanding within government of its functions and limitations and of its relationship to the President.

To give it permanence, the office should be grounded in a science policy management and oversight function that is critically needed today. That kind of strong office could lead a president to use it as his personal science advisory staff, but the decision must be made anew by each president. The President does have other ways of obtaining scientific advice, although the right kind of science office would be a preferable route in our view.

The importance of such an office being able to present its analyses and recommendations in policy terms useful to other policy-makers cannot be overestimated. This has important implications for the kind of competence required to staff and work with such a council; it also requires recognition of the fact that policy-relevant studies and advice can never be value-free, even when carried out by scientists and engineers.

And finally, such a council could bring intensive and continuous attention to the international dimension of U.S. science policy, which seems to us to be particularly neglected.

It is not yet clear whether there will be any structural changes in the new Administration. But it is not too soon to be clearer about the essential factors that should underlie a sensible proposal for this or the next Administration.

References

1. *National Academy of Sciences*, "Science and Technology in Presidental Policymaking—A Proposal," Report of the ad hoc Committee on Science and Technology, June 1974; G. B. Kistiakowsky, *Science* **184**, 38 (1974); E. B. Skolnikoff, *Public Sci.* **5**, (No. 6) 1 (1974); S32 The National Policy and Priorities for Science and Technology Act of 1974.