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Science in the White House: A New Start

Lewis M. Branscomb

The story is told that young King Solomon was given the choice between wealth and wisdom. When he chose wisdom, God was so pleased that he gave Solomon not only wisdom but wealth also. So it is with science.—ARTHUR HOLLY COMPTON (*1*)

Many scientists believe that all society should expect from science is access to the knowledge and understanding that comes from searching for truth. Certainly science has been given too much credit—and too much blame—for the uses of technology and their effects on the well-being of mankind. To be true to its own principles and promise, the world scientific community must sustain its commitment to the fullest possible understanding of man and nature. But what assurance can we have of the continued commitment of the public and its political leadership to the health of the scientific and technical enterprise?

The commitment of science to the search for truth does not free the scientist from the obligation to participate in the process through which scientific knowledge is applied. Scientists should, of course, be wary of imposing their values on others, of assuming that they know the right path for mankind to follow. But we scientists must realize that hope for a better life for future generations depends on public conviction that this hope is realistic, that there are alternatives to a Malthusian destiny. Thus the values of contemporary society are as much a consequence as a source of the commitment of science to human betterment.

American science continues to have much to contribute to the well-being of humanity. The challenges of energy, raw materials, environment, health, jobs, and improving the quality of life call for imaginative new solutions. Our industrialized trading partners pay us the compliment of emulating our tradition for innovation. The Japanese and West Germans have been particularly successful, and this success is a matter of great national pride. Communist nations place a high value on developing relationships through which they may share in American technological experience. The developing nations are particularly insistent on accelerating their own ability to ab-

The author is vice president and chief scientist at IBM Corporation, Armonk, New York 10504. This article is adapted from the text presented as the 14th Arthur Holly Compton Memorial Lecture, on 3 March 1977, Washington University, St. Louis, Missouri. The views expressed are those of the author and do not represent any institution with which he is associated.

sorb the science and technology on which their own development so heavily depends.

Yet today the spirit of conviction and commitment that is necessary to mobilize American science and engineering for constructive ends seems to be in a state of suspended animation. The dominant mood of the technical community is one of uncertainty, indeed of confusion. It saps the will and nourishes the doubts about the efficacy of science, doubts that are nurtured by examples of technological mismanagement.

The scientific community looked to the events of 1976 to put the Nixon years of indecision and mistrust behind us and mobilize a national effort to address the future with a new sense of confidence. Many scientists naively wondered why questions of scientific and technological strategy for the nation played virtually no part in the recent political campaign for the presidency. Many expected a President who had been a graduate student in nuclear engineering to move swiftly in filling the positions of Science Adviser, director of the National Science Foundation, and administrators of the National Aeronautics and Space Administration and of the Energy Research and Development Administration. A chance remark to the press by Burt Lance, director of the Office of Management and Budget, that the new budget might be reduced in the R & D area to provide funding for social programs was amplified out of all proportion to its significance by a nervous technical community. The President has been busy with problems of greater political importance. But the scientific community is eager for a clear signal from the new Administration on its attitude toward these three concerns: the efficacy of technology to meet human needs, the strength of the American scientific and technical enterprise, and the willingness of political leaders to mobilize this strength to that end.

No doubt, that signal will be forthcoming. But the process of remobilizing the American scientific and technical enterprise will be more difficult, will take longer, and will call for a more sophisticated understanding of political realities than most American scientists are prepared for.

Let me then summarize the four major themes of this discussion. Do science and technology in fact offer a realistic hope for a better future for mankind? Is the American scientific and technical community ready to respond? How should we understand the hesitation of political leadership to mobilize this capability for constructive purposes? How can the creative, pragmatic, and traditionally optimistic energies of the American technical community become fully engaged with the major issues of our times?

Are Science and Technology a Constructive Force?

The relation of science and technology to prospects for mankind was assessed last year through a project of the National Academy of Sciences. Organized as part of the academy's activities in celebration of the Bicentennial of the United States of America, 17 scientists, engineers, and scholars from eight nations gathered at Bellagio, Italy, to prepare a prospective look at science, technology, and society. The report of this Bellagio conference (*2*) was basically optimistic.

The conference reached the conclusion that it is probably within the technical and financial capacity of the world's nations to address the problems of food, population, and health in a timely manner, without the necessity of reducing the quality of life that may be enjoyed within any nation. The limits on total energy and material supply are not inexorable—at least within the foreseeable future. The "pie" is not of fixed size. An increasing share to the poor need not reduce the quality of life available to those who are more comfortably fixed.

Increasing food production in the world by a factor of between 2 and 4 by the end of the century can be accomplished, but it will require vigorous application of agricultural science and technology and associated economic infrastructure development. Similarly, the coupled energy and materials problem will call for a much wider spectrum of technological choice than is now available. While new energy sources will have to be brought into being, and present sources made safer, cheaper, and more environmentally acceptable, a major part of the energy problem must be addressed through conservation. To many, this means demand reduction, doing without something to which we have become accustomed. No doubt there is much wasteful use of energy, and this waste can easily be curtailed. But major opportunities lie in restructuring the uses to which different forms of energy are put, for the purpose both of optimizing energy strategy and raw materials strategy. Science provides an almost endless range of possibilities for reconfiguring or substituting materials, for utilizing different grades of energy, and for trading off energy and materials choices against one another.

All of this will require a vigorous range of technical activities to develop the necessary options. But on top of that requirement, one must recognize that each of these technological options is likely to be, at least when first introduced, more expensive than the traditional technology it replaces. Thus, as one looks at the necessity for new technological alternatives, one finds that there will be a need for an additional increment of technical effort to reduce the cost impact of these more expensive technologies. Thus, every area of economic activity will have to be the target of innovative increases in quality, efficiency, and productivity to avoid inflation and sustain living standards. With such productivity increases, with energy conservation, and with the use of alternative fuels and materials, we may be able to approach energy self-sufficiency and environmental quality without the kind of economic consequences to living standards that threaten the political will to persevere.

A similar argument can be made about the economic pressures that result from the public's desire to increase worker and consumer health and safety, to protect the environment, and to improve the quality of life generally. These goals, too, can most easily be met if the technological changes that they imply are accompanied by innovations that reduce their incremental costs.

I have given reasons why more, not less, science and engineering activity is needed—to create the alternatives for food, materials, and energy, to protect the environment and quality of life, and, through innovation, to reduce the cost of these alternatives. But there is a further reason, more important than the others—and that is to protect human society from catastrophic failures in the societal arrangements (systems) that will be devised as solutions to the first three problems.

The Bellagio study focused particularly on this issue—the need for protecting the resiliency of the world population. "Resiliency" is a technical term that refers to the ability of a system to find a new and satisfactory equilibrium point after it has suffered a serious perturbation. A resilient society is not immune to radical change. Indeed, it is through a lack of excessive rigidity that such a society demonstrates the capacity to accept change in order to remain viable. Too many of mankind's technological interventions with nature have been in the quest for stability, often achieved at the expense of future resiliency. A systems engineer would say that we must ensure that our social systems are resilient and have "soft failure" modes, that they do not collapse when unexpected events occur, but degrade gradually. Examples can be found in agricultural policy in relation to unanticipated changes in climate, or in relation to dependence on a small number of genetic varieties of food grains. Many examples come from the unanticipated ecological responses to selective uses of pesticides aimed at specific short-term problems. The most fundamental threat to resiliency is the quest for military stability through a policy of mutually assured nuclear destruction.

Coping with uncertainty, illuminating the consequences of technological choice, making public decisions in the absence of definitive scientific information—all place additional emphasis on the need for an aggressive mobilization of scientific and technical strength in America and around the world. Conventionally, science has been thought to be useful in proportion to the technological possibilities it creates. Today, science is more important and more frequently it is used as a means to understand the options and consequences associated with deployment of technology. Indeed, the one price that absolutely must be paid for the wide-scale use of science and technology for human betterment is the vigilance, the restraint, and, above all, the foresight to illuminate the paths ahead.

Is the U.S. Technical Community Ready to Respond?

What does it take to mobilize U.S. conviction that science and engineering can do more to solve world problems? Must we wait until we are fully persuaded that nations face certain starvation or catastrophe unless new solutions can be found? Whether the requisite positive measures are taken, of course, depends on a matter of national will in many nations and on the climate for international cooperation. But the place for us to start is at home. What of the fitness of the American scientific and technical enterprise to respond to these challenges?

On the positive side, we enjoy the largest civil research and development effort of any nation on earth. In terms of total effort and in terms of leading contributions, our science is still the envy of the world. In spite of several years of alienation between government and universities, the university research community in America contains many scientists ready and eager to apply their skills to the dominant problems of the world society and to do so in partnership with the government. Others need to be encouraged. Despite the well-publicized conflict between economic and ecological interests, our appreciation for environmental impact and technology assessment is unique in the world. Where else would (i) a \$600-million hydroelectric dam be held up to protect an endangered 3-inch freshwater fish called the snail darter, (ii) a unique butterfly enjoy priority at the end of the main runway of the Los Angeles International Airport, and (iii) the sexual aspirations of a clam threaten the construction of a nuclear power station in New Hampshire? And no longer can anyone fault the current generation of students for their unwillingness to work within the American pragmatic tradition. One worries instead about the subordination of altruism to economic necessity as young people focus their attention on jobs.

On the negative side, while the scientific community is performing brilliantly in many areas, it is enjoying it less. During the recent presidential election campaign I received many letters from scientists. None of them complained about inadequate funding from the public purse. Virtually all of them complained of burgeoning administrative red tape and of an altered relationship with government science agencies that amounted in many cases to mutual suspicion bordering on hostility.

Adding my own interpretation to much that I heard and read, I conclude that the machinery of science and its support continues to turn; but those in control of the knobs have lost confidence in the justification for science programs and, however unintentionally, communicate that loss of confidence right down to the individual investigator. Science is being justified as applied research. Applied research is directed from Washington as though it were product development. Development activities are pursued by national laboratories and agency headquarters with inadequate provision for connecting them to the technology delivery system through which the public ultimately benefits. Industry, concerned that much government-sponsored activity is disconnected from the market mechanism, watches this process with considerable chagrin, for it raises public expectations of benefits that are almost certain to be frustrated. The result can only be a further loss of public confidence in science, industry, and government, a loss that none can afford.

The situation is particularly bad in the area of science for decision-making. Excellent scientific work can illuminate the future consequences of present choices. But we have few institutions within which all the appropriate skills can be directed at major problem areas with continuity of effort over the years. The government has available to it the volunteer efforts of National Research Council committees. But while they prepare excellent reviews of what is known, they do not perform the needed interdisciplinary research.

The most telling evidence of the lack of institutional development for separating scientific fact from fiction in the public policy area is the concern many scientists today hold about their colleagues' professional integrity. Technical expertise is increasingly suspect, as the public participation in technology policy debates increases. But that participation is necessary to create consensus and motivate public action. Lay participants are not a part of the peer group whose approbation is relied on by scientists to assure objectivity. In any case, those scientists who have chosen to look for personal satisfaction in social action instead of peer approval frequently provide justification for public skepticism about technical experts, or suffer disapproval of their colleagues simply for being visible. The necessity of debating the technical facts associated with public choice, and carrying on this debate through the media so that the public can participate, is clear. Unfortunately, the traditional mechanisms for preventing the contamination of scientific objectivity by ideology do not work well in the public policy arena. New mechanisms must be evolved to encourage the participation of well-qualified scientists in both professional and public debate, with broadening public participation, and with heightened standards of objectivity and accountability.

Why Does Science Policy Not Receive Higher Priority?

A third area of concern relates to political leadership and the relation of the scientific community to that leadership. Public policy issues cannot be resolved nor institutional problems addressed without leadership as well as public participation. Many, if not most scientists assumed that, in January 1977, the Executive Branch of government would pick up science and technology policy debates at the point that they were abandoned in 1973. There have been encouraging signs. In August 1976, President Ford implemented the statute reestablishing the Office of Science and Technology Policy (OSTP) and appointed H. Guyford Stever as Special Assistant to the President for Science and Technology. President Ford also left his successor with a federal budget in which a significant increase for basic science was a point of personal pride to the budget director, James T. Lynn. President Carter sustained this increase in his budget. Trained in science and engineering, he can bring to the presidency a special personal awareness of science and technology matters. Carter placed great emphasis during the campaign on the importance of competence in the management of the Executive Branch. A $25-billion R & D segment in the 1977 budget will provide considerable scope for the exercise of technical management skills with which the President had been familiar during his naval career.

In late March President Carter nominated a distinguished and vigorous earth scientist, Dr. Frank Press, to serve as director of OSTP and as his Special Assistant for Science and Technology. But in some respects it is unfortunate that the President did not fill this position in December 1976 at the same time that he selected the chairman of the Council of Economic Advisers, the Special Assistant for National Security Affairs, and the director of the Office of Management and Budget. The Special Assistant–designate could then have participated earlier in the staffing of the science and technology policy positions throughout the government departments and specialized agencies.

One reason why science and technology policy matters have not been higher on the agenda for attention lies in the practical consequences of the recent campaign and election. In spite of what scientists want to believe about the importance and permanence of science policy in the White House, there is no well-established institutional tradition for the Special Assistant for Science and Technology to enjoy a significant role in the management of the federal enterprise. A stronger basis for this tradition resides in a few committees of the Congress, where a very substantial sophistication has developed in science and technology policy through the staffs of the House Science and Technology Committee and several of the committees of the Senate. These committees, plus the Technology Assessment Board that oversees the Office of Technology Assessment, not only kept the policy debate alive during the Nixon years, but actively advanced it in the course of establishing a legislative basis for the OSTP.

However, a rather more fundamental effect is responsible for the reduced visibility of science and technology policy in political debate. This effect has to do with the maturing of technology issues as political matters. As the President gave public issues with which the scientific community is most concerned the priority of prominence in his policy, the technical details have become proportionally less visible, although no less important. For example, in the area of most vital concern to the future of mankind—slowing down the nuclear arms race and proliferation of weapons—the President has in fact given priority to a technical strategy of high promise. Nevertheless, such issues are now discussed in terms more familiar to the public and the political process.

Reading the diary (*3*) in which George Kistiakowski records the events of his 18 months as Science Adviser to President Eisenhower, one is struck by the fact that the Science Adviser in 1959 was concerned almost exclusively with military, atomic energy, and space matters. The one exception was the contamination of the cranberry crop, just before Thanksgiving, with a pesticide believed to be carcinogenic. In those days the scientific community was just beginning to work with the Science Adviser to attract the government's attention to civil matters such as the world food problem, the future supply of fossil fuel energy, the public health consequences of agricultural and industrial chemicals, and the opportunity for science and technology to improve human life in other spheres. It was not easy at that time to mobilize public attention and action on such matters.

Fifteen years later the situation is totally changed. The public has been convinced, and in every one of these areas there exists not only one or more specialized federal agencies, but also a plethora of special and public interest groups with competent lobbies. Thus, as has been said about wars and generals, the issues of energy, environment, health, defense, and the economy are now considered too important to be left to the scientists and the engineers.

While campaigning for the presidency, Carter organized a large number of task forces on issues. The energy, environment, health, defense, and economy task forces were staffed with many people whose principal interest was essentially political. These people were not simply panels of professional experts such as one might have found in the panels of the President's Science Advisory Committee in the 1960's. In addition, to these "issue-oriented" panels, there was a task force on science and technology policy. Inevitably, this residual topic of science and technology policy was bereft of much political significance. It came to be regarded as the aggregation of those scientific and technical matters that do not lie within the framework of one of the identified significant political issues of today's society rather than as an integral part of all of them. Thus, those concerned with science and technology policy came to be viewed simply as representatives of a scientific constituency, a constituency whose priority for attention lies pretty well down the list.

While scientists and engineers cannot claim all the credit, the fact that energy, environment, and health issues have been elevated from the sphere of specialized professional advice to government and established as mature political concerns of their own represents real progress. But it does not mean that these issues do not have substantial technical content.

Instead, science and technology policy must now constitute the underlying technical strategy for finding long-term solutions to all the major issues of the day.

How Can U.S. Science and Technology Become Mobilized?

The Office of Science and Technology Policy can best serve the President by compensating for the short-term orientation of the White House and the agencies. Therefore, OSTP must reach beyond the framework of conventional political thinking and reflect a new awareness of how we must prepare for the future.

The new role for OSTP will be difficult. Today the government has less direct control over the technologies that matter to the public than it did over defense technologies in Kistiakowski's day. The private sector finances and conducts approximately 70 percent of the civil research and development in this country. The output of this research and development influences employment, productivity, and inflation, as well as all the problems associated with industrial activity. Because technological activities of public importance increasingly take place in the private sector, the government must look beyond its own research and development to obtain information about future trends and alternative technical directions. The social dimensions of civil technology activity almost always involve trade-offs between cost and benefits in which different groups of the population enjoy the benefits or suffer the costs. This aggravates the difficulty of resolving questions of risk assessment and impedes the process of rational strategy-making for the society as a whole.

Finally, a particularly difficult dimension of public policy-making results from the fact that, increasingly, public decisions will be based on predictions of risk that cannot be verified through empirical data. Impacts on nature of technological activity are initially difficult to detect when masked by the normal and unpredictable natural fluctuations. By the time these consequences have grown to the point that man-made influences exceed natural fluctuations, it may well be too late to mitigate irreversible effects. The injection of carbon dioxide into the atmosphere with a possible effect on climate is an example. In situations like this, it may be necessary to make very important decisions (such as whether to place primary reliance on coal as an energy source for the next 25 years) in the absence of empirical determinations of the consequences (in this case of increased concentration of carbon dioxide). In such circumstances, public decisions must be based on simulations, theoretical predictions, and sophisticated interpretation of statistics. The government is poorly equipped to make decisions on this basis, and the public is ill prepared to accept them. Even if the basis for decision is clear, it is a serious political challenge to persuade the public to forego substantial near-term benefits to reduce the likelihood of a theoretical disaster in the remote future.

If indeed we are convinced that the mobilization of scientific and technological capabilities can substantially ameliorate the threats to America's future and if the technical community stands ready to respond to that challenge, what is needed to make progress? Five areas of public policy need special attention.

1) The fundamental necessity is a mechanism for generating national strategies for ensuring the adequacy and proper use of energy, of materials, and of the other resources and systems on which our national well-being depends. No single institution can possibly accomplish this task, although many people have proposed a fourth branch of government or other structural devices to address it. I believe we cannot look to one agency, to one congressional committee, or to one private body to generate such strategies. Instead, we need to focus on the importance of strategy-making itself. To that extent a limited set of mixed public and private commissions established by the Congress with the cooperation of the Administration might serve a useful purpose. We must invent new mechanisms, compatible with our democratic political traditions, that permit the generation of a national consensus behind a strategy whose validity extends well beyond the time horizon of elected officials.

2) The management of the government's research and development activities must be substantially improved. The OSTP has a crucial responsibility in this area. Today a large part of the R & D budget is frittered away on demonstration projects that teach us little about the elements of technical risk and also fail to demonstrate market acceptance or economic viability. Nevertheless, demonstration projects reflect the frustration of the Congress in seeking to broaden the political support for accelerated technology to meet public needs. For working with the private sector the government must develop better patterns that emphasize generating needed technologies within the industries that are expected to deliver their benefits to the public.

3) High priority must be given to mastering the technological component of economic health. No other major industrial nation manages its economic affairs without a ministry for industrial and technological matters. In this respect functions and capabilities of the Department of Commerce need to be rethought. The department requires extensive upgrading of its capability to evaluate technological strengths and weaknesses in industrial sectors on a microeconomic level. In the absence of this capability, it will be difficult to generate any meaningful strategy for applying our technological skills to the generation of jobs, limiting inflation, and improving international competitiveness.

4) The government should pull together its efforts to strengthen the national scientific and technological infrastructure, recognizing the crucial importance of basic research and the need to rebalance university research around rising technical opportunities and shrinking numbers of students. Serious consideration should be given to the organization of a national science and technology administration based on elements of the National Science Foundation, National Bureau of Standards, and National Aeronautics and Space Administration and deploying a pool of national laboratories and centers. Such a new agency would invest in science and engineering research and education and in applied research for basic technologies; it would provide a full range of scientific and technical services necessary to support the productive application of science and engineering in the private sector.

5) Particularly urgent is the provision of long-term funding for research institutions that focus on the technical, social, and economic aspects of major public issues of high technical content. Two examples of such institutions are Resources for the Future and the International Institute for Applied Systems Analysis. Such research institutes should focus not only on the domestic aspects of environment, climate, agriculture, energy, and the like, but should cover the international aspects as well. Most important they should look 10 to 20 years into the future and attempt to provide a rigorous, documented basis for analysis of policy alternatives that will assure a resilient future for mankind.

These few examples suffice to indicate that the structural changes that are needed will not be easy to accomplish. They are unlikely to arise from the traditional governmental focus on short-term objectives. They will require initiative and leadership from the White House, and the informed consent of the public, neither of which is likely to be effective without the active efforts and support of the technical community.

This effort we owe to future generations, for without it the promise of science may yield only bitter fruit.

References and Notes

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