

SOURCE: Q 127 .U6 S327

AUTHOR: Carnegie Commission on Science, Technology, and Government

DOCTITLE: Science, Technology, and Congress: Expert Advice and the  
Decision-Making Process

SECTITLE: Science, Technology, and Congress: Expert Advice and the  
Decision-Making Process

DATE: 1991

SUBJECT: R&D research development Congress United States science  
technology policy research budget funding federal agency OTA  
Office of Technology Assessment Library of Congress General  
Accounting Office Congressional Budget Office

PUBLISHER: Carnegie Commission on Science, Technology, and Government

DOCTYPE: Book

TITLEID: CC9105

ISBN\_ISSN:

Text:

SCIENCE, TECHNOLOGY,  
AND CONGRESS  
EXPERT ADVICE AND THE  
DECISION-MAKING PROCESS

February 1991

Reprinted October 1993

CONTENTS

PREFACE

ACKNOWLEDGMENTS

1.0 EXECUTIVE SUMMARY

1.1 Recommendations for Consideration by Congress

1.2 Recommendations for Consideration by the Scientific and  
Engineering Communities

2.0 SCIENCE, TECHNOLOGY, AND CONGRESS

2.1 Congress and Science and Technology Policy

2.2 Domains of Science Policy and Technology Policy

2.3 Basis for Recommending Reforms

3.0 SCIENTIFIC AND TECHNICAL INFORMATION AND POLICY DECISION MAKING

3.1 Information, Analysis, and Advice for Congress

4.0 NEW DIRECTIONS FOR THE 1990S AND BEYOND

4.1 Recommendations for Consideration by Congress

4.2 Recommendations for Consideration by the Scientific and  
Engineering Communities

5.0 LESSONS FOR THE FUTURE

6.0 NOTES AND REFERENCES

7.0 MEMBERS OF THE CARNEGIE COMMISSION ON SCIENCE, TECHNOLOGY, AND  
GOVERNMENT

8.0 MEMBERS OF THE ADVISORY COUNCIL, CARNEGIE COMMISSION ON SCIENCE,  
TECHNOLOGY, AND GOVERNMENT

9.0 MEMBERS OF THE COMMITTEE ON SCIENCE, TECHNOLOGY, AND CONGRESS

PREFACE

The Carnegie Commission on Science, Technology, and Government was  
established in April 1988 to assess the mechanisms by which the federal

government and the states incorporate scientific and technological knowledge into policy-making processes. Within the Commission, the Committee on Science, Technology, and Congress examines issues specific to the legislative branch of the federal government. The Committee's activities are guided by a Congressional Advisory Council composed of more than 40 Senators and Representatives.

This is the first of four reports prepared by the Committee. Science, Technology, and Congress: Expert Advice and the Decision-Making Process focuses on the mechanisms by which Congress receives and uses information and expert analyses and advice from sources outside Congress, including academia, industry, nongovernmental organizations, and others.

The second report will examine analysis and advice on science and technology (S&T) issues provided by the four congressional support agencies: the Office of Technology Assessment, the Congressional Research Service of the Library of Congress, the General Accounting Office, and the Congressional Budget Office.

Congressional procedures, including appropriations, authorization, and oversight of S&T programs, will be the focus of the third study. The final report will examine ways that Congress can gain a longer-term perspective on S&T issues, executive-legislative branch interactions, scientific literacy, how an informed electorate influences the congressional agenda, and the role of the media in informing the public of S&T-related issues.

After reviewing the role of Congress in shaping science and technology policy and describing the information needs of the legislative branch, this report presents a series of recommendations for improving the ways that Congress receives and uses scientific and technical information. The recommendations are grouped into two major categories, those for consideration by Congress and those directed to the scientific community.

ACKNOWLEDGMENTS

This is a report of the Carnegie Commission on Science, Technology, and Government and was prepared by the Committee on Science, Technology, and Congress:

John Brademas (chair)  
Jimmy Carter  
Lawton Chiles  
Daniel J. Evans  
Charles McC. Mathias, Jr.  
H. Guyford Stever

The Committee's work is guided by a Congressional Advisory Council. The members of the Council are:

Senators

Brock Adams  
Jeff Bingaman  
Robert Dole  
Pete Domenici  
E.J. (Jake) Garn  
John Glenn  
Albert Gore, Jr.  
Charles E. Grassley  
Mark O. Hatfield  
Ernest F. Hollings  
Daniel K. Inouye  
Edward M. Kennedy  
Frank R. Lautenberg  
Larry Pressler  
Harry Reid  
John D. Rockefeller, IV  
Terry Sanford  
Ted Stevens

Tim Wirth

Representatives

Les Aspin

Jim Bates

Tom Campbell

Silvio O. Conte

Sherwood L. Boehlert

George E. Brown, Jr.

Vic Fazio

Hamilton Fish

Richard A. Gephardt

Bill Green

Lee H. Hamilton

Lynn Martin

Sid Morrison

Leon E. Panetta

David E. Price

Don Ritter

Robert A. Roe

James H. Scheuer

Claudine Schneider

Bob Traxler

Morris K. Udall

Doug Walgren

Robert S. Walker

Tim Valentine

In the course of its studies, the Committee discusses issues and policy directions with current and former Members of Congress and their staff, managers and staff of the congressional support agencies, public policy experts, and representatives of the scientific and engineering communities. The Committee greatly appreciates the thoughtful advice and suggestions that it has received, and it has attempted to prepare a report that

addresses the concerns of the many individuals with an interest in these issues. However, individual members of the Congressional Advisory Council and others do not necessarily endorse the conclusions or recommendations that follow.

The Committee is indebted to the many congressional staff who have been particularly generous with their time and resources. Their insights and suggestions were indispensable to the production of this report.

The Committee wishes to acknowledge the excellent contributions of its consultants for this report, including James E. Katz, Marcel C. LaFollette, and Jeffrey K. Stine. The invaluable assistance and advice of Richard P. Barke throughout this study was most appreciated. In addition, the suggestions of Commission staff members Jesse H. Ausubel, David Z. Beckler, and David Z. Robinson were very helpful.

The Committee is grateful to Rodney W. Nichols of the Commission's Advisory Council and Executive Committee for his assistance throughout the study. The Committee also acknowledges the many helpful suggestions of the participants at its July 1990 Conference on Science, Technology, and Congress: Joel D. Aberbach, Richard P. Barke, Richard N. Brandon, John W. Ellwood, John Ferejohn, Christopher Foreman, Stephen E. Frantzich, Don E. Kash, David C. Mowery, Catherine Rudder, James D. Savage, Carol H. Weiss, and Joseph White.

Staff to the Committee on Science, Technology, and Congress are:

Mark Schaefer, Senior Staff Associate

Kathryn L. Edmundson, Assistant to John Brademas

David A. Kirsch, Program Associate[\*]

Alexandra M. Field, Program Assistant

This report was adopted by the Carnegie Commission at its meeting on October 31, 1990. The Commission is grateful to Dr. John Brademas, the

members of the Committee, the Congressional Advisory Council, and the Congressional staff, consultants, Commission staff, and others who contributed to the report.

Joshua Lederberg, Co-Chair

William T. Golden, Co-Chair

Endnote

[\*] Until August 1990

## 1.0 EXECUTIVE SUMMARY

In the next decade and beyond, Congress will be required to make critical decisions on a broad range of domestic and international issues involving science and technology (S&T), including environmental protection, energy resources, economic competitiveness, national security, and public health. These issues, which raise complex social, economic, ethical, and legal questions, are a central concern to most congressional committees. Indeed, it is difficult to identify any committee whose work does not involve policy decisions that influence, or are influenced by, science and technology.

As the legislative branch of the federal government, Congress is on the front line of many battles over the directions of science and technology. The quality of congressional decisions on these issues often depends on the quality and usefulness of information and analysis made available to Congress by scientists, engineers, and others.

The Carnegie Committee on Science, Technology, and Congress is responding to a sense of concern and frustration among Senators and Representatives, and leaders both within and outside the federal government, that the S&T system in the United States is not working as well as it should. Senators and Representatives are finding it increasingly difficult to address science and technology issues effectively. Moreover, the system for

establishing science and technology policy is not adapting easily to the changes and pressures of recent years, including an increasingly constrained federal budget and growing requests for resources.

This report focuses on ways that Congress can enhance its capabilities to carry out its multiple functions in the scientific and technological arena by obtaining high-quality and timely information and advice from the scientific community. Our report also describes how the scientific community can best serve the needs of Congress as it works to shape science and technology policy.

It should be noted that recommendations contained in this report are not addressed to the congressional support agencies. Ways of enhancing S&T analysis and advice from the support agencies will be examined in the Committee's second report.

#### 1.1 Recommendations For Consideration By Congress

- The Committee recommends that Congress establish a bipartisan Science and Technology Study Conference or related bicameral legislative service organization to function as a focal point for the timely analysis of science and technology-related legislative issues, to develop strategies to address matters that cut across multiple committees, and to facilitate the acquisition and dissemination of information on S&T-related activities.

A bipartisan Science and Technology Study Conference patterned after the existing congressional Environmental and Energy Study Conference could serve as a valuable mechanism to promote communication and coordination between the many congressional committees and subcommittees with S&T responsibilities. Concomitant with such a study conference, the Committee suggests that Congress encourage the establishment of a nonprofit Science and Technology Study Institute to provide weekly bulletins, briefings, legislative analyses, workshops, training, and conferences on major issues



before Congress.

- The Committee recommends that Congress improve its approaches to obtaining S&T analyses and advice from the scientific community.

First, to increase opportunities for free exchange of ideas, Congress could make greater use of informal meetings or conferences to discuss scientific and technical issues in more depth. Second, Congress should develop a mechanism to allow committees to obtain rapid-response technical analyses by small groups of scientists, engineers, and others. Third, both congressional committees and individual Members should make more frequent use of informal advisory groups to examine approaches to address S&T policy issues.

- The Committee recommends that Congress devise a way to make direct requests for certain studies to the National Academy of Sciences complex.

Congress typically initiates a study by the National Academy of Sciences complex by providing funds to an executive branch agency. This indirect approach can mean a delay in getting a study under way, modification of the congressional request by an executive agency, and difficulties if the study is administered by an executive branch agency that believes its established policies or practices may be adversely affected by the conclusions of the study. The capacity of Congress to make direct requests for certain studies would mitigate some of these difficulties.

As such direct requests would require an alternative congressional funding mechanism, the Committee believes two approaches may be feasible: a) Funds could be provided to congressional authorizing committees specifically for the purpose of funding studies by the Academy, or b) Congress could make an endowment grant to the Academy to allow compensation for studies initiated at the direct request of congressional committees.

- The Committee recommends that Congress more frequently use the

results of the scientific merit review process in making decisions on the funding of science and technology projects and facilities.

Merit review can serve as an effective guide in making many science and technology policy decisions. The merit review process provides a mechanism for experts to reach a consensus on the relative quality of competing proposals for federal funds. The process is also useful at the performance review stage and can guide decisions on continuing funding of existing projects, programs, and facilities.

- The Committee recommends that Congress make scientific and technical information developed at hearings and elsewhere more readily available to the scientific community and to the public.

Two-way communication is critical to the decision-making process, and Congress is better served if scientists, engineers, and policy-making experts are kept informed of legislative activities. Congress should make hearings testimony and reports more readily available to the S&T community and should consider more frequent production of brief, high-quality summaries of hearings that focus on major S&T issues. Congress should consider ways to make better use of the media in publicizing S&T-related hearings and other activities.

## 1.2 Recommendations For Consideration By The Scientific And Engineering Communities

- The Committee recommends that the Congressional Science and Engineering Fellows Program be strengthened and expanded.

Members of Congress have been very pleased with the Congressional Science and Engineering Fellows Program. Since 1973, more than 450 Fellows, usually recent university graduates with advanced degrees, have worked for a one-year period as staff to committees and individual Members. Approximately

one-third of the Fellows remain in positions on the Hill to work for varying lengths of time beyond their fellowship year.

Throughout the years, the demand for Fellows has consistently outstripped the supply. This past year, for example, more than 90 committees, subcommittees, and personal offices expressed an interest in having a Fellow. Only 23 individuals were available. The Committee believes nongovernmental organizations should make an effort to sponsor more Congressional Fellows to meet the increasing demand.

- The Committee recommends that more scientists, engineers, and others become actively involved in science and technology policy activities.

Universities and professional societies could do more to inform scientists and engineers of the linkages among science, technology, and public policy and the benefits of greater participation in policymaking activities. The federal government could take steps to encourage the scientific community to participate in public activities. Schools, colleges, and universities should encourage and reward individuals who participate in activities pertaining to public understanding of science and technology and their impact on society. Corporations, professional societies, and nongovernmental organizations should encourage scientists, engineers, and others in their organizations to become more actively involved in public activities.

In this regard, the Commission is supporting the development of a practical guide for scientists and engineers to assist them in providing Senators and Representatives and their staff with information, analyses, and advice.

- The Committee recommends that the National Academy of Sciences complex strengthen its capabilities to meet congressional analytical and advisory needs.

The Academy should consider communicating regularly with Members of

Congress and their staff; preparing more frequent summaries of Academy reports in nontechnical, easily understood formats; expanding its capacity to respond to congressional requests for short studies and briefings on a rapid turnaround basis; and promoting discussion of report findings and recommendations.

\* \* \*

In conclusion, the Committee found that Senators and Representatives and their staff need more information of high quality that is directed specifically to the issues of concern to them and is available at the time an issue is being addressed. Information that is accurate, balanced (with biases clearly identified), properly packaged, readily accessible, and delivered in timely fashion is most influential during the congressional decision-making process.

The members of the Committee on Science, Technology, and Congress hope these recommendations will stimulate further discussion of and debate on approaches to improving communications between Congress and the scientific community and thereby strengthen the capacity of Congress to make wise decisions on science and technology policy issues.

## 2.0 SCIENCE, TECHNOLOGY, AND CONGRESS

In the 1990s and beyond, legislators will be required to make critical decisions on a broad range of domestic and international issues involving science and technology. Issues related to economic competitiveness, environmental protection, energy resources, national security, and public health are likely to dominate the national policy agenda.

If Thomas Jefferson or Benjamin Franklin were to join the spectators in the Senate or House galleries today, they would undoubtedly be puzzled by both the language and the level of detail of the debate over throw weights and megatons, chlorofluorocarbons and stratospheric ozone depletion, and the

scope and direction of research to combat the AIDS epidemic. The nature of the debate on the issues before Congress today is very different from that of 200 years ago; indeed, the debate is very different from that of 20 years ago and, given the rapid pace of scientific and technological advances, it will change considerably in the decades ahead as the needs of society change and new problems surface.

In recent years, science and technology have emerged as the source of many of the most important and complex challenges facing Congress. The activities of the communities and subcommittees of the Senate and the House of Representatives, their caucuses and study groups, and the congressional support agencies demonstrate Justice Felix Frankfurter's prescription:

"There must be science in government, because science dominates society."

[1]

Scientific and technological changes raise complex social, economic, ethical, and legal issues that are regularly discussed and debated in hearing rooms and on the floors of the Senate and House. Indeed, it is difficult to identify a single congressional committee that does not make policy decisions that influence, or are influenced by, science and technology.

First and foremost, Congress is an institution of the people. Congress is the forum through which 250 million Americans can address the federal government, and it is therefore the focal point for the debate of national issues. As the legislative branch of the federal government, Congress is on the front line of many battles over the direction of science and technology: between the emphasis placed on basic research and the development of commercial technologies, between support for several large and expensive "megaprojects" (big science) and thousands of small research grants to individual investigators (little science), and between responsiveness to national needs and protection of scientific autonomy. The quality of congressional debate on these issues depends in part upon the quality and usefulness of the information made available to Congress by scientists, engineers, and others.

With but a handful of exceptions, the 100 Senators and 435 Representatives who cast the votes that ultimately determine the direction of U.S. science and technology policy are not scientists or engineers. Yet legislators are called on to weigh the pros and cons of highly technical questions and alternative courses of action. To evaluate and formulate opinions on the complex S&T issues of today, legislators and their staff rely heavily on the opinions of scientists, engineers, and others in the private sector and in executive agencies. Often this information is received by way of experts in the congressional support agencies, particularly the Office of Technology Assessment and the Congressional Research Service.

Enhancing the linkages between Congress and the scientific community is a challenging task. The world of science and the world of politics are different in many ways, and there has long been an uneasy relationship between the two. Scientists have as much difficulty adapting to politics as legislators have in adapting to science. As one scholar has put it, "Members of Congress have faith, based on hope, that scientists can provide them with simple answers. Scientists have hope, based on faith and training, that much remains for them to discover." [2] In the past, the differences between what have sometimes been referred to as the "two cultures" [3] were often used as an excuse for poor communication. In recent years, however, efforts have been made to bridge the worlds of science and politics, largely out of recognition that effective communication is crucial to sound policy making and future scientific and technological progress.

Through the years, Congress has been very supportive of science and technology. Funds for major institutions such as the National Science Foundation and the National Institutes of Health have grown substantially, even in times of economic difficulty. Such support is largely a reflection of public interest in science and technology and recognition of the benefits they bring to society.

## 2.1 Congress And Science And Technology Policy

Congress does not have a single, discrete mission. Its constitutional mandate and its position in American government and politics require it to pursue simultaneously many goals, not all of which are mutually reinforcing. Congress establishes policies, a task that requires it to identify pressing public problems, formulate alternative policy solutions, and choose the best from among them. Members of Congress also represent their constituents, focusing, articulating, and balancing the needs and demands of the diverse interests in American society. And Congress oversees the implementation of its decisions, working with the executive branch in a delicate political dance in which it is often unclear which branch of government is leading the other. Typically, congressional decisions are based on awkward balances of objective analysis and political pragmatism, facts and perceptions, and careful planning and short-term crisis management.

Congress influences science and technology policy in many different ways. Congress supports S&T by establishing and funding research agencies and programs, and in so doing generates both "policy for science" and "policy for technology." The reasons for supporting science include its intellectual and cultural values, its usefulness as the basis for technological development, its role in education, and its importance in international affairs. [4] Congress has supported technology in many ways and for many reasons, mostly in the context of the central role of technology in economic development and national security, [5] as well as in the context of the missions of individual federal agencies. An important aspect of congressional policy making is to encourage and enable the private sector to develop technologies that will help achieve the nation's social and economic objectives. [6]

Congress also controls S&T by mandating the regulation of some aspects of scientific research (e.g., the use of human subjects and the release of genetically engineered organisms into the environment) and many products of technological development (e.g., nuclear power, telecommunications, and

environmental pollution). As Congress is called on to decide when and where to intervene in the S&T process, it often confronts the difficult question of how to protect public health and safety or how to advance our national security interests without impinging unnecessarily on scientific and technological progress. [7]

Finally, Congress uses scientific and technical information in making policy decisions about most major national issues. Decisions regarding the precise technical details of specific issues frequently are delegated to executive branch agencies. Yet Congress needs scientific and technological information to carry out its legislative and oversight activities. As Congress applies scientific information to the solution of a wide range of policy problems, it has evolved a variety of formal and informal techniques for obtaining information and analysis, creating an unsteady balance between delegated discretion and legislative control. [8]

This report focuses on the ways that Congress can enhance its capability to carry out the above functions by obtaining high-quality and timely information and advice from the scientific community and using it effectively. The report also suggests ways that the scientific community can best serve the needs of Congress as it works to shape science and technology policy. Analysis and advice from the four congressional support agencies will be the subject of the Committee's second report.

## 2.2 Domains Of Science Policy And Technology Policy

Science policy and technology policy are not easily defined. Science policy tends to focus on government and academic research efforts, the size of research and facility budgets, the adequacy of training programs, and the extent to which the missions of federal agencies are being supported by research efforts. Technology policy frequently focuses on applying the accomplishments of basic and applied research to solving specific problems or to reaching defined goals. It involves questions regarding the funding of technologies ranging from space vehicles or weapons systems to devices



to control pollution or to diagnose and treat diseases and illnesses.

Science policy and technology policy cannot be neatly separated; indeed, much of the political support for public funding of scientific research has derived from the nation's faith in the practical technological application of what began as basic science. Furthermore, it is well understood that the simple causal model relating scientific research to technological application is flawed. [9] Focusing on either science policy or technology policy alone is therefore risky.

Science policy and technology policy share a number of important characteristics. As Congress attempts to support, control, and use either science or technology, it is faced with the task of obtaining timely and usable information and analysis concerning topics about which few Members or staff are knowledgeable. Science and technology policy making is particularly challenging because it often requires anticipation of future accomplishments; however, the occasional breakthroughs that are responsible for giant leaps forward in a particular discipline cannot be predicted. Science and technology present challenges and opportunities for policy makers to balance knowledge, uncertainty, social values, and political responsiveness.

In general, the process of establishing policy for science is less contentious than that of establishing policy for technology. The reason, in part, is that a consensus exists that the federal government has a necessary role to play in funding basic research. It is widely accepted that much important basic research would not be performed without public support. [10] There are, however, varying views with respect to the extent of government involvement in technology policy because technology policy making implies, to some, establishing "industrial policy," an activity that many feel impinges upon the domain of the private sector. [11]

In the course of its work, the Committee has attempted to devise recommendations that will be applicable to both science and technology, while recognizing that distinctions between the two may make some

recommendations more relevant to one than the other.

### 2.3 The Basis For Recommending Reforms

Many of the science and technology policy challenges currently facing Congress are not new. Indeed, among the concerns that motivated Congress to create the Office of Technology Assessment in 1972, many seem familiar today: the need for better communication across scientific and engineering disciplines and among scientists, the public, and policy makers; the need for better information on the social and political effects of S&T; the need to identify long-term trends and emerging problems; the need for greater cooperation among business, academia, and government; and the importance of priority setting and establishing national goals.

The Committee developed its recommendations on the assumption that budgetary constraints are likely to persist, that committees and Members will not yield power readily, and that legislators will continue to seek and use a variety of electoral, economic, strategic, and ideological justifications for supporting or opposing S&T programs.

The Committee is responding to a sense of concern and frustration among Senators and Representatives and leaders both within and outside the federal government that the S&T system in the United States is not working as well as it should. The system for making science and technology policy is not adapting easily to the changes and pressures of recent years, including an increasingly constrained federal budget, a growing number of expensive big science projects, and the desire of some policy makers to emphasize the application of research and development to problems related to international competitiveness.

Moreover, Senators and Representatives are finding it increasingly difficult to address science and technology issues. Much of the difficulty results from the decentralization of authority inherent in a large legislative body. At the same time, in many respects Congress functions

very well. Its record of legislative accomplishments over the past 200 years is unparalleled in the history of democratic institutions. Congress embodies the inherent conflict between rational decision making and the articulation of the values of its constituents. Congress makes choices without being constrained by artificial boundaries of thinking along a single dimension (such as trying to measure all programs on a simple cost-benefit scale). It retains procedures and structures that protect the ambiguities that are vital to bargaining and the formation of coalitions, such as organizational fragmentation and overlap, and sharing of powers within Congress and with the executive branch.

In attempting to identify ways that Congress might function better with respect to science and technology, the Committee has tried to avoid recommendations that might inadvertently weaken the system it hopes to strengthen. The Committee has also kept in mind the need to avoid recommendations that may have unforeseen negative secondary impacts. [12] It has also proposed changes that are flexible enough to adapt to larger institutional pressures and to respond to new and evolving demands and constraints.

### 3.0 SCIENTIFIC AND TECHNICAL INFORMATION AND POLICY DECISION MAKING

Because effective communication with the S&T community is essential to the congressional policy-making process, the Committee's first two studies examine the mechanisms by which Congress seeks, receives, and utilizes analysis and advice from scientists, engineers, public policy experts, and others.

In developing science and technology policy, legislators frequently find themselves interposed between the expert and the public, attempting to mediate often-competing interests and demands. Members rely on their own educational backgrounds, political experiences, and common sense to chart a course toward a goal that is politically practical. Elected officials must condense, modify, and refine the advice of scientists and engineers in the context of national needs and political reality.

Often elected officials are unfamiliar with the characteristics and applications of science and technology. In particular, those trained as lawyers typically address issues by looking for precedent and for certainty. They tend to think and speak in qualitative as opposed to quantitative terms. Yet the objective of science and technology is often to depart from precedent and certainty and to move into the realm of uncertainty, probability, and risk, which are often measured and assessed quantitatively. Consequently, those providing scientific and technical information to Congress should strive to do so in a manner that is accessible and persuasive to individuals who often view problems and solutions in different terms. [13]

### 3.1 Information, Analysis, And Advice For Congress

Information, analysis, and advice are most useful to Senators and Representatives and their staff when presented in such a way that they can be readily applied to the decision-making process. Members and their staff rarely have the time to make use of detailed reports, highly technical briefings, or comprehensive accounts of the progress and future plans of various scientific disciplines. Members need information that will help them foresee future societal needs in terms of economics, quality of life, and national security. Without an ability to foresee likely challenges and opportunities, elected officials find themselves planning in the context of the past and present rather than the future.

Timing is a critical factor in attempting to provide Congress with information, analysis, and advice that will have an impact on the decision-making process. The most salient and thoughtful advice is of little use if it is delivered after Congress has achieved a consensus on a new policy direction. Therefore, a balance must be struck between the desire of scientists and engineers to provide information that is technically accurate and complete, and the political necessity to make decisions in a timely manner. Often Members must resolve technical questions and make

policy decisions before a scientific consensus on the nature of a problem or the path to solving it has been clearly identified. This is a matter of political reality and does not stem from a lack of understanding of, or respect for, the scientific method.

Congress receives scientific and technical information from a wide variety of sources. Although Members have access to careful analyses by experts on virtually any scientific and technical issue, they often rely on general, nontechnical information from the mass media, informal conversations, and debates of related issues. [14] Senators and Representatives also frequently look to each other for advice, deferring decisions to those who have taken the time to develop expertise or to evaluate an issue thoroughly. And they often rely heavily on the analyses of one or more of the four congressional support agencies when making science and technology policy decisions. Analysis and advice from the support agencies will be discussed in detail in the Committee's second report.

Much scientific and technical information reaches a Member through conversations with personal and committee staff or by way of hearings. Although congressional staff are flooded with reports, newsletters, and newspaper and journal articles, of most use to them are brief, nontechnical reports that summarize key facts, present policy issues and options, and suggest a course of action that takes into account political and economic realities. The information received by staff rarely has all of these characteristics.

Analytic information is useful to legislators and their staff in several ways. Such information may support preexisting policy positions, it may alert them to problems that should be the subject of congressional attention, it may guide them in making choices between policy options, or it may enlighten them, giving them a new perspective on an issue. [15] Of course, presenting information to Congress does not mean that Congress will use it in formulating policy. Improving congressional decision making requires not just better analysis and advice, but mechanisms to assure that high-quality information is recognized and actually used.

Trust is the key to access to Members and staff. Information provided by an organization or individual without a proven track record of sound judgment is likely to be viewed cautiously and with some skepticism. Therefore, the Committee found that building relationships and creating mechanisms to nurture trust are as important as improving the quality of analyses available to Congress.

#### 4.0 NEW DIRECTIONS FOR THE 1990s AND BEYOND

With all these considerations in mind, the Committee has attempted to develop practical suggestions both to improve the quality of scientific and technical information provided to Congress by experts outside Congress and to enhance Congress's capability to analyze this information and use it in making decisions. The recommendations that follow are in two parts: The first set is addressed to Congress itself and the second to scientists, engineers, and others, as well as to the organizations that employ them or with which they are associated.

##### 4.1 Recommendations For Consideration By Congress

- The Committee recommends that Congress establish a bipartisan Science and Technology Study Conference or related bicameral legislative service organization to function as a focal point for the timely analysis of science and technology-related legislative issues, to develop strategies to address matters that cut across multiple committees, and to facilitate the acquisition and dissemination of information on S&T-related activities.

Because authority in Congress is highly decentralized, examining science and technology as a whole and coordinating the often overlapping activities of the many committees and subcommittees with science and technology-related responsibilities are often difficult. Communication is a major challenge not only to legislators and their staff, but to those outside

Congress who have an interest in the national policies it helps shape. The effective acquisition, use, and dissemination of scientific and technical information are critical to the congressional decision-making process.

In 1975, eleven Members of Congress concerned about the need for better information on which to base energy and environmental policy decided to form the Environmental and Energy Study Conference. Today the Study Conference has a bipartisan membership of 375 Senators and Representatives and is the largest legislative service organization in Congress. [16]\_ In addition to analyzing issues before Congress, the Study Conference publishes a weekly legislative report that has proven to be a highly useful source of information on Hill activities. The Study Conference also prepares background materials on legislation and sponsors a briefing and seminar program to promote the discussion of policy issues with Members and staff. This approach to communication and dissemination of information with respect to energy and the environment could be applied to broader science and technology issues as well.

Complementing the activities of the Study Conference is the Environmental and Energy Study Institute, a nonprofit policy organization that publishes a weekly legislative bulletin for individuals and organizations outside Congress, convenes seminars, and publishes special reports on policy issues. The Institute is governed by a Board of Directors that includes current and former Members of Congress and leaders in the environmental policy field. Private foundations are the Institute's primary source of funding.

Major science and technology policy decisions are made by numerous congressional committees and subcommittees. This decentralization of responsibility makes the exchange of scientific and technical information among committees and subcommittees in both houses of Congress a particular challenge. It also presents challenges to those in the scientific community who desire to stay informed of congressional S&T-related activities and to those who may wish to provide information to legislators and their staff.

A bipartisan Science and Technology Study Conference patterned after the Environmental and Energy Study Conference would serve as a valuable mechanism to promote communication and coordination among the many congressional committees and subcommittees with S&T responsibilities. Such a study conference could facilitate the development of strategies for addressing S&T issues, serve as a focal point for discussion of broad policy issues, analyze hearings, aid in the identification of expert witnesses, [17] and sponsor conferences, seminars, and briefings on major issues. Such a conference could also help identify potential S&T-related studies by the congressional support agencies and could serve as liaison for studies that involve issues that cut across multiple committees in both the Senate and the House of Representatives. In this context, the conference would function to build bridges between the many committees and subcommittees addressing S&T issues. If Congress establishes a Science and Technology Study Conference, the Committee believes it important to define clearly the Conference's functions in the context of existing activities of the congressional support agencies. By focusing on near-term legislative issues, the Institute's activities would augment the existing activities of the Office of Technology Assessment and the Congressional Research Service.

Congress should also encourage the establishment of a nonprofit Science and Technology Study Institute. Unlike the Science and Technology Study Conference, the Institute could obtain operating funds from foundations and other sources, allowing it greater flexibility in supporting a range of activities. The Institute could complement the work of the Study Conference by preparing a weekly legislative bulletin similar to the one prepared by the Environmental and Energy Study Conference, by providing educational briefings, by undertaking legislative analyses, and by sponsoring workshops and conferences on major issues before Congress. This might include training and educational seminars for congressional staff who have responsibilities in the S&T area. The Institute could provide a weekly bulletin of congressional activities to individuals and organizations outside Congress on a subscription basis, and could facilitate the flow of information between Congress and the scientific and engineering



communities.

In addition, a Science and Technology Study Institute could coordinate the preparation of rapid-response analyses for congressional committees and individual Senators and Representatives. This effort might include rapid-response analyses by experts in academia, industry, nongovernmental organizations, and elsewhere. This issue is discussed further in the following section.

- The Committee recommends that Congress improve its approaches to obtaining S&T analyses and advice from the scientific community.

Although congressional hearings offer a mechanism for scientists, engineers, and others to present views to Members and staff, there is little opportunity for productive interactions in this formal setting.

Congress could make more use of informal meetings or conferences to discuss scientific and technical issues in greater depth. Where appropriate, such meetings could precede hearings in order to explore ideas and lay the groundwork for further, more formal, discussions. There are advantages to convening some conferences of this kind outside Washington in a setting that would permit a free and uninterrupted exchange of ideas. Any of several nongovernmental organizations (NGOs) might be willing to sponsor such meetings. The National Academy of Sciences complex, the Aspen Institute, the Keystone Center, and other organizations and academic institutions have periodically sponsored such events. At times, a series of meetings or a continuing dialogue can be very useful in informing Members and staff of policy issues. For example, since 1986, the Aspen Institute has sponsored an ongoing series of conferences on U.S.-Soviet relations for Members of Congress with policy-making responsibilities in this area. In reaching a consensus on future policy directions, participants have found these meetings both educational and productive.

Meetings of this kind could be initiated at the joint request of committee or subcommittee chairs and ranking minority members, by a Science and

Technology Study Conference, or by nongovernmental organizations based on their perceptions of congressional needs.

Among the studies most useful to Senators and Representatives and their staff are analyses undertaken by the Office of Technology Assessment and the National Academy of Sciences in response to specific congressional requests. However, such studies typically take 12 to 24 months to produce. Whether the analysis is of varying views on the feasibility of a new technology, the promise of a medical procedure, a novel approach to pollution control, or the efficacy of an improved weapons system, by the time it is complete, a policy decision may have already been made and the issue may no longer be on the congressional agenda.

Congress should develop a mechanism to allow committees to request or obtain routinely rapid-response technical analyses by small groups of scientists, engineers, and others. Although less perfect than exhaustive studies, scientific and technical analyses prepared on a quick-response basis (one to four months) are of great value to Congress because they are generated in a time frame consistent with congressional needs. A mechanism to permit routine requests and funding of these types of studies would make it possible for individuals in academia, nongovernmental organizations (including professional societies and policy institutes), and industry to undertake analyses and present findings and recommendations for action at hearings or at private meetings with Members and staff. [18]

Members of Congress have occasionally called on organizations to examine specific S&T issues over a short period of time and to report back to congressional committees with their findings and recommendations. Efforts of this kind have proven to be very effective in getting key information to requesting Members and committees. For example, the Senate Subcommittee on Science, Technology, and Space recently requested that several professional societies undertake brief studies of certain issues under consideration by the Subcommittee. Members found such directed studies to be particularly useful.

Some years ago, the House Armed Services Committee asked a number of experts throughout the country to examine a series of technical issues associated with naval antisubmarine warfare capabilities. The quality of the report was excellent and, because the study panel interacted closely with Committee staff and answered questions specifically posed by Committee Members, the analysis was highly focused. However, the inability of the Committee to pay consulting fees or even reimburse panel members for expenses was a major concern to Members and staff. Unless such obstacles can be overcome, it is unlikely that congressional committees will take advantage of analyses of these kinds in the future. [19]

Rapid-response analyses could be commissioned directly by committees. Use of this approach in the past has generally been limited to situations in which no funds were transferred from the committee to the organization or individuals undertaking the study. At times this approach is feasible, but the requesting committee is dependent upon the good will of the study organization. Congress could consider various approaches for initiating rapid-response analyses. One mechanism is to use a Science and Technology Study Institute to coordinate the production of studies of this kind. This approach would allow funding of studies through the Institute, which would receive its funds primarily from private foundations.

Another mechanism to support the production of these studies is to provide funds directly to committees for contracting for such activities. If this approach were to be taken, it would be necessary to segregate contracting funds from funds for other committee purposes to assure the use of these funds for the production of studies. One drawback of this approach is that contracting would most likely prove to be an administrative burden on committees.

Another alternative is to rely on the congressional support agencies to administer the studies. Either the Office of Technology Assessment [20] or the Congressional Research Service of the Library of Congress could coordinate rapid-response studies at the request of committees. One

limiting concern is that use of this approach might preclude the development of policy recommendations -- a valuable aspect of rapid-response studies undertaken by experts in academia, industry, and nongovernmental organizations. To maintain their independence and to preserve their nonpartisan status, support agencies generally avoid making recommendations. These and other issues with respect to the congressional support agencies will be examined in detail in the Committee's second report.

Other approaches to obtaining information and advice are also worthy of congressional consideration. Many Senators and Representatives have in their districts either academic institutions or industries that employ scientists and engineers. Often, Members either overlook or are not aware of the tremendous wealth and diversity of technical talent among their own constituents. Researchers have traditionally avoided involvement in political issues; when called on, however, they are usually willing to provide assistance on specific issues over a short period of time.

Both congressional committees and individual Members should make greater use of informal advisory groups to examine approaches to address S&T policy issues. Committees could more often avail themselves of the scientific talent throughout the nation, and individual Members could take more advantage of the talent in their states and districts. Ad hoc working groups, for example, can be convened to examine particular issues under debate. Such groups can, quickly and on a confidential basis when necessary, provide Senators and Representatives analyses and advice. For example, some Members have regularly met with scientists and engineers from their home state to explore issues and to learn more about research activities. [21] Such regular meetings are not only useful from the standpoint of the transfer of information, but also build trust, an essential ingredient in assuring that analyses and advice are actually used during the decision-making process. Similarly, congressional committees may find it useful to convene ad hoc working groups composed of experts from throughout the country to examine, over a defined period of time, specific

issues. Later in this report we make recommendations related to preparing scientists and engineers to provide advice and analysis to Congress in this manner.

Congress should develop mechanisms to compensate scientists and engineers for travel expenses associated with providing formal testimony to committees and subcommittees. Individuals who testify before Congress often devote considerable time to preparation of their testimony. In most cases it is considered a privilege to serve as an expert witness, and individuals are pleased to devote their time to preparing a statement for the committee. However, funds for travel are limited and individuals frequently encounter difficulties in obtaining compensation for expenses. If committees could reimburse those who present testimony, it would alleviate the necessity for scientists and engineers to locate funds or to use personal resources.

- The Committee recommends that Congress devise a way to make direct requests to the National Academy of Sciences complex for certain studies.

The National Academy complex including the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council is the nation's premier organization of scientists and engineers. The National Academy of Sciences' charter, signed by President Lincoln in 1863, states, "The Academy shall, whenever called upon by any department of the government, investigate, examine, experiment, and report upon any subject of science or art." Academy studies are generally acclaimed for their consistent high quality. Studies typically take 18 to 24 months to complete, although the Academy does occasionally undertake analyses on a shorter turnaround.

Congress typically initiates a study by the Academy complex by providing funds to an executive branch agency. This indirect approach can mean either a delay of several months to one year or more in getting a study underway, modification of the congressional request by an executive agency, or

difficulties when the study is administered by an executive branch agency that believes its established policies or practices may be adversely affected by the conclusions of the study. The capacity of Congress to make direct requests for certain studies would mitigate some of these difficulties.

Among the types of studies Congress might wish to request directly from the Academy are those that federal agencies might be reluctant to support because of complex jurisdictional relationships, differing values or approaches to problem solving, or those that might be politically sensitive or likely to involve issues that an agency might prefer not to address.

The direct request for Academy studies would require an alternative congressional funding mechanism. The Committee believes at least two approaches may be feasible.

Congressional authorizing committees could be appropriated funds specifically for the purpose of requesting studies by the National Academy of Sciences complex and perhaps other nongovernmental organizations. Such an approach could be tried on an experimental basis (perhaps over a five-year period) by providing such funds to selected House and Senate committees.

Alternatively, Congress could make an endowment grant to the Academy to allow compensation for studies initiated at the direct request of congressional committees. Over the years, the Academy has periodically entertained the idea of seeking a one-time grant from the federal government to allow more flexibility in undertaking studies from various sources, [22] and the concept has been discussed in at least one congressional hearing. [23] Regardless of the funding mechanism, if Congress chooses to request directly Academy studies, the Committee believes it necessary for Congress and the Academy to agree upon guidelines to protect the Academy's independence in selecting a study committee, in carrying out a study, and in undertaking reviews to assure the accuracy and

quality of the resulting final report. The Academy correctly resists efforts by those who request studies to influence the findings and recommendations of its reports. As the Academy has stated in the past, Committees of the Academy and the National Research Council "have always been shielded from the immediate political pressure that often limits the horizons of advisory groups within the governmental structure. It is imperative that that shield not be breached." [24]

- The Committee recommends that Congress more frequently use the results of the scientific merit review process in making decisions on the funding of science and technology projects and facilities.

Federal agencies and the scientific community have developed an effective system for examining the merits of proposals for science and technology projects, programs, and facilities. Through this system, individuals and institutions that demonstrate the most promise for accomplishment receive federal funds on a priority basis. Although this system is imperfect, the merit review process provides a mechanism for experts to reach a consensus on the relative quality of competing proposals for federal funds. A system such as this, which is open, fair, and subject to public scrutiny, can effectively guide funding decisions. Merit review is also useful at the performance review stage, guiding decisions on continued funding of existing activities and facilities.

Elected officials do not make decisions in a political vacuum, and Congress should not be expected to leave major funding decisions entirely to the merit review process. One reason lobbying for federal funds for science facilities has increased in recent years is that resources are very limited and federal policies are viewed by some as not assuring an equitable distribution of resources. Critics of the existing system believe that the merit review process is controlled by the well-known, established institutions and that it is difficult for developing institutions to gain funding. Nevertheless, the product of merit review -- a ranking of proposals based on technical merit -- can serve as an effective guide when

making many science and technology policy decisions. As Frank Press, President of the National Academy of Sciences, stated some years ago, "The excellence of our national research has been sustained by a system for assuring optimal use of public funds: a competitive review evaluation process to assure that projects and facilities selected for funding are those which most merit support in terms of the overall health of scientific research." [25]

- The Committee recommends that Congress make scientific and technical information developed at hearings and elsewhere more readily available to the scientific community and to the public.

Although Congress is a major user of scientific and technical information, it is also a source of useful and important information to the scientific community. Two-way communication is critical to the decision-making process, and Congress is better served if scientists, engineers, and policy-making experts are kept informed of the congressional activities.

Hearings provide a mechanism for Senators and Representatives to listen to presentations from and ask questions of expert witnesses on scientific and technical issues. Hearings are useful in enhancing public awareness of issues. In addition, they function as a forum for the oversight of executive branch activities. Over the last two decades, the number of hearings held on S&T-related issues has substantially increased, particularly in the House of Representatives. [26]

Although hearings are primarily designed to provide information to legislators and their staff, they are useful to the S&T community, academic scholars, and the public in general as a source of information on the range of views on major science and technology policy issues. Yet individuals outside Congress who would benefit by a greater awareness of issues being evaluated and debated often have difficulty obtaining information about committee activities. Currently, individual committees and subcommittees must be contacted for such information, but the ease of obtaining



information varies significantly.

Congress may wish to make hearings testimony and reports more readily available to the S&T community. One approach would be to establish a centralized system for cataloging, maintaining, and distributing hearings, testimony, and other committee documents. Perhaps the Government Printing Office and the Congressional Research Service could assist in developing a plan for enhancing the maintenance and distribution of congressional documents. Another approach would be to make information on the availability of reports more readily accessible to organizations that can disseminate such information. For example, major journals that reach the scientific and engineering community could regularly publish information on past hearings, the witnesses that provided testimony, and ways to obtain hearing reports.

Congress should encourage more frequent production of brief, high-quality executive summaries of hearings that focus on major S&T issues. Concise, high-quality executive summaries of selected S&T hearings can be invaluable both to Congress itself and to scientists, engineers, public policy experts, federal officials, and the public if they are produced in a timely fashion. Such summaries would be useful as a means of conveying information to individuals in academia, industry, and nongovernmental organizations, as well as to the media. Summaries would also help focus increased public attention on S&T policy issues, enhance scientific literacy and public understanding of scientific problems, and catalyze greater public involvement in the debate over policy responses. A Science and Technology Study Conference or Institute, for example, could establish contractual arrangements for preparing such summaries. Alternately, the Congressional Research Service has in the past periodically prepared such summaries. Congress could provide CRS additional funds to support the more frequent production of them.

As it becomes easier for individuals in academia, industry, and elsewhere to gain access to information on congressional activities, more people with expertise in particular policy areas will be prepared to provide useful

input to Congress.

Congress should make more effective use of the media in publicizing S&T-related hearings and other activities. The media are a very effective mechanism for informing the public of policy issues, yet congressional S&T-related activities are seldom the subject of press attention. Regularly scheduled informal meetings with Members -- such as press breakfasts or other gatherings -- to discuss issues before Congress could lead to a better appreciation and hence improved coverage of scientific and technical issues. Enhancing the scientific literacy of the public will require significant improvement in media coverage of the social and political aspects of S&T policy issues.

Congressional activities are the source of a wealth of information on science, technology, and society. More of this information should reach the American people in a format that they can read and understand. More frequent coverage of S&T-related hearings by C-Span, for example, would also improve public access to information on current science and technology policy issues. A Science and Technology Study Conference or one or more congressional support agencies could help coordinate more congressional outreach activities. This issue will be examined in greater depth by the Committee in its fourth report.

#### 4.2 Recommendations For Consideration By The Scientific And Engineering Communities

Members of Congress have been very pleased with the Congressional Science and Engineering Fellows Program. Since 1973, more than 450 Fellows, usually recent university graduates with advanced degrees, have worked for a one-year period as staff to committees and individual Members. Approximately one-third of the Fellows typically stay on to work for varying lengths of time beyond their fellowship year. Today a number of former Fellows hold continuing committee and personal staff positions.

- The Committee recommends that the Congressional Science and Engineering Fellows Program be strengthened and expanded.

Throughout the years, the demand for Fellows has consistently outstripped the supply. This past year, for example, more than 90 committees, subcommittees, and personal offices expressed an interest in having a Fellow. Only 23 individuals were available.

Nongovernmental organizations should make an effort to sponsor more Congressional Fellows to meet the demand of committees and the individual offices of Senators and Representatives. Devoting the necessary resources to sponsoring a Congressional Fellow has become increasingly difficult for some nongovernmental organizations. Unfortunately, over the life of the program, about a dozen organizations have terminated their support for Fellows for a variety of reasons, chiefly lack of money. The Committee encourages NGOs that currently sponsor Fellows to continue doing so and to attempt to find the means to support additional individuals. In addition, the Committee urges organizations not currently supporting Fellows to consider initiating programs. As a goal, the Committee believes that nongovernmental organizations should sponsor an annual total of at least 50 congressional science and engineering Fellows by the year 2000.

An effort could be initiated by the American Association for the Advancement of Science (AAAS), which already sponsors two Fellows of its own and coordinates the entire program, to endow a number of fellowship positions. This goal might be achieved by seeking grants from foundations that could be matched by donations from other sources.

It is important to stress that organizations sponsoring Congressional Fellows should continue to remain vigilant regarding potential conflict-of-interest situations. Nongovernmental organizations that support Fellows could improve efforts to screen individuals who may have conflicts of interest; they could also expand efforts to inform Fellows of the difficulties that such conflicts can present.

Nongovernmental organizations should consider establishing a senior congressional fellowship program that would allow scientists and engineers in senior level positions to work for committees and individual Members while on academic sabbaticals or leaves of absence from industry. Such a program could prove a valuable resource to Congress and would provide senior scientists and engineers an opportunity to experience congressional policy making first hand. It is notable that one professional organization in particular, the Institute for Electrical and Electronic Engineers (IEEE), currently supports several Congressional Fellows, all of whom are engineers in senior level positions. Members' offices and committees have found these individuals among the most helpful and productive Congressional Fellows.

- The Committee recommends that more scientists, engineers, and others become actively involved in science and technology policy activities.

Scientists and engineers have tended to shy away from involvement in policy activities, preferring to work in their technical area of expertise unencumbered by the "unscientific" vicissitudes of the political world. Yet it is the political process that determines the size of federal grants, examines issues such as R&D tax credits, leads to the laws that regulate research activities, and determines who will lead the federal agencies that support research and development programs. In recent years, scientists and engineers have become increasingly involved in national policy decisions; the Committee believes an acceleration of this trend would prove useful to both Congress and the scientific community.

It is in the interest of scientists and engineers to communicate with the public and to become involved in the policy debates that shape the direction of science and technology and the way the nation uses the results of research and development efforts. The Committee is not suggesting that all researchers involve themselves in policy activities, but that those who are sensitive to the political context within which science is conducted

and who can effectively communicate their views and those of their colleagues become more active in policy-making activities.

Universities and professional societies should do more to inform scientists and engineers of the linkages among science, technology, and public policy and the benefits of greater participation in policy-making activities. Universities and professional societies should tap the talent within their organizations and encourage individuals with policy-making expertise to communicate their experiences with colleagues. These organizations should also develop information and sponsor activities that will encourage greater understanding of policy-making procedures.

The federal government should encourage the scientific community to participate in public activities. Federal agencies do not routinely encourage outreach efforts on the part of grantees and federal scientists and engineers. These agencies should explore the possibility of making more funds available for nonpolitical, public policy-related activities. Intramurally, federal agencies should support programs designed to bring federal scientists in closer contact with the public. The Department of Energy, for example, has recently instituted a successful program to allow federal scientists and engineers to teach science courses in local schools.

As the nation becomes increasingly dependent upon science and technology in its everyday affairs, social, ethical, and political concerns will permeate the work of the scientist and the engineer. Those who conduct research and develop the technologies of tomorrow should participate more often in the public decisions that shape the way society uses the results of their work.

Schools, colleges, and universities should encourage and reward individuals who participate in activities pertaining to the public understanding of science and technology and their impact on society. Too often institutions base tenure and promotion decisions solely on research accomplishments and place little value on important "extracurricular" activities that are beneficial to both the scientist and society.

Corporations, professional societies, and nongovernmental organizations should encourage scientists, engineers, and others in their organizations to become more actively involved in public activities. These organizations could develop and disseminate information on congressional activities and provide guidance to individuals on how to become more involved in policy-making activities. This information could include appropriate and effective ways to provide analysis and advice to Members of Congress and their staff.

Most scientists and engineers have little experience in interacting with the legislative branch of the federal government. The hearings process, for example, is well suited to lawyers, but not to scientists who are unaccustomed to the formality of providing testimony and answering questions in terms easily understood by the layperson. The Committee on Science, Technology, and Congress is supporting the development of a practical guide for scientists and engineers in providing Senators and Representatives and their staff with information, analyses, and advice. It is hoped that this guide will aid individuals in preparing and presenting testimony, in providing informal advice to Members and staff, and in providing information to and participating in the activities of the congressional support agencies.

Professional organizations could also experiment with ways to make the expertise of their members more readily available to Congress. One proposal to facilitate interactions is to establish readily accessible databases containing information on scientists, engineers, and others who can be called on by Members and staff for information in particular areas of scientific and technical specialization. [27]

- The Committee recommends that the National Academy of Sciences complex strengthen its capabilities to meet congressional analytical and advisory needs.

The National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and the National Research Council, collectively

termed the Academy complex, provide a wealth of outstanding S&T advice to the federal government. The Academy complex is highly regarded for its ability to assemble the best scientific and technical experts in the country to prepare comprehensive reports on national issues. Congressional interest in using Academy resources has increased substantially in recent years. For example, in the period from 1983 to 1989, the annual number of Academy studies mandated by public law grew from 2 to 18, and testimony before Congress increased in similar fashion. [28] In light of this heightened interest, the Committee has examined several potential approaches to strengthening the Academy's capabilities to serve Congress.

The National Academy of Sciences complex should enhance efforts to communicate regularly with Members of Congress and their staff. In recent years, the Academy has initiated several activities to communicate more effectively with Congress, including an annual gathering in Woods Hole, Massachusetts, to discuss current major science and technology policy issues, and periodic informal briefings and dinner sessions to discuss issues on the congressional agenda. In addition, in 1988 the National Research Council developed guidelines for interactions between Congress and the organizations within the Academy complex. The guidelines encourage individuals to "respond constructively to congressional requests for information that does not include policy or legislative recommendations." [29]

Although these activities have proven very effective, the Committee believes that the Academy complex could strengthen its interactions with Congress. The Academy is not intended to be a direct support service organization for Congress, but can be more effective in meeting congressional information needs.

The Committee encourages the Academy complex to prepare summaries of its reports more frequently, presenting information in a nontechnical, easily understood format. This effort might include improving executive summaries or preparing separate summary documents designed specifically for policy makers. In addition, the Academy could routinely invite congressional staff

to attend briefings on the findings and recommendations of newly released reports.

The Committee also encourages the Academy to expand its capabilities for responding to requests for short studies and briefings on a rapid turnaround basis. Studies or research briefings have been undertaken occasionally at the request of executive branch agencies; rapid-response reports would be particularly valuable to Congress as well, particularly if they could be prepared in a time frame that would allow their presentation at congressional hearings (which are often organized on short notice). At times, providing information on a rapid-response basis may only require that established experts in a particular field prepare a nontechnical summary of existing information in the context of a congressional issue or concern. If Congress is to be able to request rapid-response studies on a regular basis, a mechanism to allow congressional committees to transfer funds easily to the National Academy complex to support the production of such reports must be developed, or the Academy complex would need to have access to discretionary funds that could be used for this purpose. Possible funding mechanisms were described earlier in this report (see page 32).

The Committee also recommends that the Academy complex take steps to promote discussion of report findings and recommendations. In recent years, the Academy has made progress in this area. Although the Academy is prohibited from lobbying, it can conduct seminars, facilitate meetings between study committee participants and Members of Congress and staff, and expand efforts to make Congress aware of completed work that is relevant to issues currently under consideration. The National Academy of Engineering (NAE) regularly sponsors luncheons with congressional staff and some executive agency officials to discuss current (primarily NAE-related) activities and to explore issues of interest to Congress. In addition, the Committee on Science, Engineering, and Public Policy (COSEPUP) regularly holds similar meetings on technology policy issues. Other Academy units might consider organizing similar activities. A Science and Technology Study Conference could serve as a liaison between the Academy complex and



Congress in planning and coordinating activities of this kind.

## 5.0 LESSONS FOR THE FUTURE

In the course of its analysis, the Committee found that Senators and Representatives and their staff do not need more information; however, they do need more information of high quality that is directed specifically to the issues of concern to them and is available at the time the issue is being addressed. Information that is accurate, balanced (with biases clearly identified), properly packaged, readily accessible, and delivered in timely fashion is most influential during the congressional decision-making process.

In the coming decades, Americans may travel to Mars, a commercial fusion reactor may become a reality, medical life support systems will become increasingly sophisticated, the human genome is likely to be sequenced in its entirety, and electricity rather than gasoline may power the nation's automobiles. Nurturing the scientific and technological advances of tomorrow is a complicated undertaking that can have enormous social and economic consequences.

As Congress attempts to address existing problems and to anticipate those of the future, the accelerating pace of scientific and technological change will increasingly strain the legislative process. Which projects should go forward most quickly, and which ideas should mature before backing them with billions of dollars? How should the federal government be organized to foster scientific and technological innovation? How can the United States maintain its competitive position in an increasingly globalized economy? What are the social and ethical implications of the development of certain technologies? These are the kinds of questions that Congress will face in the future, and the answers will not come easily.

Legislators and their staff will look to the "experts" for ideas and guidance, but the information Congress receives may be conflicting, inconsistent, or politically impractical. If elected officials are to steer

the United States effectively through the challenges of the years ahead, the quality of analysis and advice provided to Congress should be no less than excellent. The Committee believes that assuring that Congress receives the best information will require more active involvement on the part of scientists and engineers in policy-making activities. Bruce L. R. Smith eloquently described the challenge facing the scientific community:

For scientists to wrap themselves in the mystique of their craft, to resist immersing themselves in the muddy issues of policy, or to block public involvement would fly in the face of the logic of their situation. Perhaps more than ever they need public support for the enterprise of science and public understanding of what it can and cannot contribute to national objectives. If scientists are sometimes uncomfortable venturing beyond their immediate expertise, they may take comfort in challenging the hucksterism, shrillness and plain lack of information that often distort public debate of complex technical and related policy issues. [30]

This report has attempted to identify some ways to assure that scientists, engineers, public policy experts, and others are appropriately, indeed optimally, linked to the congressional science and technology policy-making process. The members of the Committee on Science, Technology, and Congress hope that these recommendations will stimulate further discussion of and debate on approaches to improving communication between Congress and the scientific community, and will thereby strengthen the capacity of Congress to make wise decisions on science and technology policy issues.

#### 6.0 NOTES AND REFERENCES

[1] Felix Frankfurter, *The Public and its Government* (New Haven: Yale University Press, 1930).

[2] Richard P. Barke, *Science, Technology and Public Policy*

(Congressional Quarterly Press, 1986); Richard P. Barke, "Beyond the 'Endless Frontier': Changes in the Political Context of American Science and Technology Policy." Paper presented at the Annual Meeting of the Society for Social Studies of Science, 1990.

[3] C. P. Snow, *The Two Cultures and the Scientific Revolution* (New York: Cambridge University Press, 1959).

[4] Michael D. Reagan, *Science and the Federal Patron* (New York: Oxford University Press, 1969).

[5] Harvey Brooks, "National Science Policy and Technological Innovation," in Ralph Landau and Nathan Rosenberg, eds. *The Positive Sum Strategy: Harnessing Technology for Economic Growth* (Washington, DC: National Academy Press, 1986).

[6] Malcolm A. Weiss, personal communication to the Committee on Science, Technology, and Congress; Carnegie Commission on Science, Technology, and Government (September 12, 1990).

[7] U.S. Congress, Office of Technology Assessment, *The Regulatory Environment for Science--A Technical Memorandum, OTA-TM-SET-34* (Washington, DC: U.S. Government Printing Office, 1986).

[8] Gary C. Bryner, *Bureaucratic Discretion: Law and Policy in Federal Regulatory Agencies* (New York: Pergamon Press, 1987).

[9] Nathan Rosenberg, *Inside the Black Box: Technology and Economics* (New York: Cambridge University Press, 1982).

[10] Kenneth J. Arrow, "Economic Welfare and the Allocation of Resources for Invention," in *The Rate and Direction of Inventive Activity: Economic and Social Factors* (Princeton: Princeton University Press, 1962), pp. 609-625.

[11] Richard Nelson and R. N. Langlois, "Industrial Innovation Policy: Lessons from American History," *Science*, vol. 219, 1983, pp. 814-818; Richard Nelson, "Government Support of Technology Progress: Lessons from History," *Journal of Policy Analysis and Management*, Vol. III, Fall 1983, pp. 499-514; David Mowery and Nathan Rosenberg, *Technology and the Pursuit of Economic Growth* (New York: Cambridge University Press, 1989).

[12] John Ferejohn, personal communication to the Committee on Science, Technology, and Congress (1990). At the Committee's July 1990

meeting on Science, Technology, and Congress, John Ferejohn underlined the importance of anticipating the consequences of procedure reforms. He pointed out that "there is no general connection between good procedures and good consequences . . . such a connection must be demonstrated not assumed."

[13] Malcolm A. Weiss, 1990.

[14] Carol Weiss, "Congressional Committees as Users of Analysis," *Journal of Public Policy Analysis and Management*, pp. 411-431.

[15] Ibid.

[16] Legislative service organization (LSOs) are organizations established by Members of Congress that must meet certain criteria regarding membership and sources of income in order to have their staff, housing, and certain other expenses paid from congressional operating funds. They are distinct from the congressional support agencies--the Office of Technology Assessment, the General Accounting Office, the Congressional Research Service of the Library of Congress, and the Congressional Budget Office--all of which are legislative branch agencies funded directly by congressional appropriations.

[17] Marcel C. LaFollette and Jeffrey K. Stine, *Congressional Hearings on Science and Technology Issues: Strengths, Weaknesses and Suggested Improvements*, background paper prepared for the Committee on Science, Technology, and Congress of the Carnegie Commission on Science, Technology, and Government, 1990.

[18] Mark Schaefer, *Rapid Response Scientific and Technical Analysis for Congress*, background paper prepared for the Committee on Science, Technology, and Congress of the Carnegie Commission on Science, Technology, and Government, 1990.

[19] Ibid.

[20] Rodney W. Nichols, *Future Directions for the Office of Technology Assessment*, background paper prepared for the Committee on Science, Technology, and Congress of the Carnegie Commission on Science, Technology, and Government, 1990.

[21] Barke, 1986.

[22] Dael Wolfle, National Academy of Science, National Academy of

Engineering, Institute of Medicine and the National Research Council, a report to the Task Force on Nongovernmental Organizations in Science and Technology, Carnegie Commission on Science, Technology, and Government, January 1990.

[23] U.S. Congress, U.S. House of Representatives, Hearings before the Task Force on Science Policy of the Committee on Science and Technology, Science Policy Study--Hearings vol. 21, The Role of the National Academies (Washington, DC: U.S. Government Printing Office, 1986).

[24] National Academy of Sciences, "A Proposal for a Congressional Endowment for the National Academy of Sciences," unpublished draft, 1980.

[25] Frank Press, letter of May 27, 1986, to the Honorable John C. Danforth, printed in the Congressional Record, June 5, 1986, p.S.6891.

[26] LaFollette and Stine, 1990.

[27] James E. Katz, Mechanisms for Providing Science Advice to Congress: Current Status, Unresolved Problems, and Possible Solutions, background paper prepared for the Committee on Science, Technology, and Congress for the Carnegie Commission on Science, Technology, and Government, 1990.

[28] National Research Council, "Trends in NRC Administration and Management," 1990.

[29] National Research Council, memorandum dated September 8, 1988, to professional staff on guidelines for legislative relations of the NRC/NAS/NAE/IOM.

[30] Bruce L. R. Smith, American Science Policy Since World War II (Washington, DC: The Brookings Institution, 1990).

## 7.0 MEMBERS OF THE CARNEGIE COMMISSION ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

William T. Golden (Co-Chair)  
Chairman of the Board  
American Museum of Natural History

Joshua Lederberg (Co-Chair)  
University Professor

Rockefeller University

David Z. Robinson (Executive Director)

Carnegie Commission on Science, Technology, and Government

Richard C. Atkinson

Chancellor

University of California, San Diego

Norman R. Augustine

Chair & Chief Executive Officer

Martin Marietta Corporation

John Brademas

President Emeritus

New York University

Lewis M. Branscomb

Albert Pratt Public Service Professor

Science, Technology, and Public Policy Program

John F. Kennedy School of Government

Harvard University

Jimmy Carter

Former President of the United States

William T. Coleman, Jr.

Attorney

O'Melveny & Myers

Sidney D. Drell

Professor and Deputy Director

Stanford Linear Accelerator Center

Daniel J. Evans

Chairman

Daniel J. Evans Associates

General Andrew J. Goodpaster (Ret.)

Chairman

Atlantic Council of The United States

Shirley M. Hufstedler

Attorney

Hufstedler, Kaus & Ettinger

Admiral B. R. Inman (Ret.)

Helene L. Kaplan

Attorney

Skadden, Arps, Slate, Meagher & Flom

Donald Kennedy

Bing Professor of Environmental Science

Institute for International Studies and

President Emeritus

Stanford University

Charles McC. Mathias, Jr.

Attorney

Jones, Day, Reavis & Pogue

William J. Perry[\*]

Chairman & Chief Executive Officer

Technology Strategies & Alliances, Inc.

Robert M. Solow

Institute Professor

Department of Economics

Massachusetts Institute of Technology

H. Guyford Stever

Former Director

National Science Foundation

Sheila E. Widnall

Associate Provost and Abby Mauze Rockefeller Professor of Aeronautics and  
Astronautics

Massachusetts Institute of Technology

Jerome B. Wiesner

President Emeritus

Massachusetts Institute of Technology

Endnote

[\*] Through February 1993

8.0 MEMBERS OF THE ADVISORY COUNCIL, CARNEGIE COMMISSION ON SCIENCE,  
TECHNOLOGY, AND GOVERNMENT

Graham T. Allison, Jr.

Douglas Dillon Professor of Government

John F. Kennedy School of Government

Harvard University

William O. Baker

Former Chairman of the Board

AT&T Bell Telephone Laboratories

Harvey Brooks

Professor Emeritus of Technology and Public Policy

Harvard University



Harold Brown  
Counselor  
Center for Strategic and International Studies

James M. Cannon  
Consultant  
The Eisenhower Centennial Foundation

Ashton B. Carter  
Director  
Center for Science and International Affairs  
Harvard University

Richard F. Celeste  
Former Governor  
State of Ohio

Lawton Chiles  
Governor  
State of Florida

Theodore Cooper[\*]  
Chairman & Chief Executive Officer  
The Upjohn Company

Douglas M. Costle  
Former Administrator  
U.S. Environmental Protection Agency

Eugene H. Cota-Robles  
Special Assistant to the Director  
National Science Foundation

William Drayton

President

Ashoka Innovators for the Public

Thomas Ehrlich

President

Indiana University

Stuart E. Eizenstat

Attorney

Powell, Goldstein, Frazer & Murphy

Gerald R. Ford

Former President of the United States

Ralph E. Gomory

President

Alfred P. Sloan Foundation

The Reverend Theodore M. Hesburgh

President Emeritus

University of Notre Dame

Walter E. Massey

Director

National Science Foundation

Rodney W. Nichols

Chief Executive Officer

New York Academy of Sciences

David Packard

Chairman of the Board

Hewlett-Packard Company

Lewis F. Powell, Jr.[+]  
Associate Justice (Ret.)  
Supreme Court of the United States

Charles W. Powers  
Managing Senior Partner  
Resources for Responsible Management

James B. Reston  
Senior Columnist  
New York Times

Alice M. Rivlin[%]  
Senior Fellow  
Economics Department  
Brookings Institution

Oscar M. Ruebhausen  
Retired Presiding Partner  
Debevoise & Plimpton

Jonas Salk  
Founding Director  
Salk Institute for Biological Studies

Maxine F. Singer  
President  
Carnegie Institution of Washington

Dick Thornburgh  
Undersecretary General  
Department of Administration and Management  
United Nations

Admiral James D. Watkins (Ret.)[#]

Former Chief of Naval Operations

Herbert F. York

Director Emeritus

Institute on Global Conflict and Cooperation

University of California, San Diego

Charles A. Zraket

Trustee

The MITRE Corporation

Endnotes

[\*] Died April 1993

[+] Through April 1990

[%] Through January 1993

[#] Through January 1989

#### 9.0 MEMBERS OF THE COMMITTEE ON SCIENCE, TECHNOLOGY, AND CONGRESS

John Brademas, Committee Chairman, served in the U.S. House of Representatives from 1959 to 1981, the last four years as Majority Whip. He is currently the President of New York University.

Jimmy Carter was the 39th President of the United States and was the Governor of the State of Georgia from 1971 to 1975. He served in the Georgia State Legislature from 1963 to 1967.

Lawton Chiles served in the U.S. Senate from 1971 to 1989. He was a member of the Florida House of Representatives from 1958 to 1966, and the Florida Senate from 1966 to 1970. He is currently the Governor of the State of Florida.

Daniel J. Evans served in the U.S. Senate from 1983 to 1989. He was

President of Evergreen State College in Washington from 1977 to 1983, and was Governor of the State of Washington from 1964 to 1977. He served in the Washington House of Representatives for 11 years beginning in 1956.

Charles McC. Mathias, Jr., served in the U.S. Senate from 1969 to 1986. Prior to being elected to the Senate, he served in the U.S. House of Representatives from 1961 to 1969 and in the Maryland House of Delegates from 1959 to 1960.

H. Guyford Stever was Director of the National Science Foundation from 1972 to 1976, serving concurrently as Science Advisor to Presidents Nixon and Ford. He was Director of the White House Office of Science and Technology and Policy from 1976 to 1977. Prior to joining NSF, he was President of Carnegie-Mellon University.