SCIENCE, TECHNOLOGY, AND CONGRESS

ANALYSIS AND ADVICE FROM THE CONGRESSIONAL SUPPORT AGENCIES

OCTOBER 1991
Reprinted OCTOBER 1993

A Report of the

CARNEGIE COMMISSION
ON SCIENCE, TECHNOLOGY, AND GOVERNMENT

The Carnegie Commission on Science, Technology, and Government was created in April 1988 by Carnegie Corporation of New York. It is committed to helping government institutions respond to the unprecedented advances in science and technology that are transforming the world. The Commission analyzes and assesses the factors that shape the relationship between science, technology, and government and is seeking ways to make this relationship more effective.

The Commission sponsors studies, conducts seminars, and establishes task forces to focus on specific issues. Through its reports, the Commission works to see that ideas for better use of science and technology in government are presented in a timely and intelligible manner.

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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 is examining 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 second of four reports prepared by the Committee. *Science, Technology, and Congress: Analysis and Advice from the Congressional Support Agencies* focuses on the contributions to congressional policy-making made by each of the four 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.

The Committee's first report, *Science, Technology, and Congress:*

Expert Advice and the Decision-Making Process, was devoted to the mechanisms by which Congress receives and uses information, expert analyses, and advice from sources outside Congress, including academia, industry, and nongovernmental organizations.

Congressional procedures, including appropriations, authorization, and oversight of S&T programs, will be the focus of the third study. The Committee's final report will examine 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 science- and technology-related information needs of Congress and the efforts of the four support agencies to meet these needs, the Committee on Science, Technology, and Congress presents in this report a series of recommendations for enhancing the analytical and information-gathering capabilities of these agencies.

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:

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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 issues raised. 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 members who have been particularly generous with their time and resources. Their insights and suggestions were indispensable to the production of this report.

The Committee also appreciates the many comments and suggestions provided by managers and staff of the congressional support agencies. The Committee's primary contacts in the support agencies were John H. Gibbons (Office of Technology Assessment), Richard E. Rowberg (Congressional Research Service), J. Dexter Peach (General Accounting Office), and Elliot Schwartz (Congressional Budget Office).

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This report was adopted by the Carnegie Commission at its meeting on June 26, 1991. The Commission is grateful to Dr. John Brademas; Dr. H. Guyford Stever, the principal committee member for the study; the members of the Committee; the Congressional Advisory Council; and the Congressional staff, consultants, Commission staff, and others who contributed to this report.

William T. Golden, Co-Chair
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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.

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 Congressional support agencies: Office of Technology Assessment (OTA), Congressional Research Service (CRS) of the Library of Congress, General Accounting Office (GAO), and the Congressional Budget Office (CBO).

FINDINGS

The Committee on Science, Technology, and Congress makes four major findings with respect to the congressional support agencies:

- The support agencies perform a critical role in the development of science and technology policy by evaluating issues, translating technical information, and describing alternative courses of action. Although there is some overlap, each agency has developed its own niche, serving an essential analytical and advisory function for Congress.

- The support agencies serve as an important reservoir of institutional memory, providing intellectual continuity in a rapidly changing political environment. The Committee believes that this form of institutional memory is a valuable intellectual asset and should be preserved, enhanced, and, wherever possible, applied.

- Resources available to the support agencies have not kept pace with the rising demand for information; hence, agency activities are increasingly constrained. Since the demand for support agency services will undoubtedly continue to rise through the next decade, either Congress must allow the support agencies more flexibility in prioritizing requests—including declining requests to undertake studies—or, if Congress intends to rely on these organizations for technical information of quality, it must provide additional resources.

- The globalization of science and technology issues has more and more driven Congress into the international arena. Although the support agen-

cies have to some degree responded to this trend, strengthening of support agency operations will be necessary to meet increasing congressional requests for internationally oriented scientific and technical information, analysis, and advice.

RECOMMENDATIONS

The report is divided into three types of recommendations: those for consideration by Congress; those for consideration by the congressional support agencies collectively; and those addressed to each individual support agency.

RECOMMENDATIONS FOR CONSIDERATION BY CONGRESS

The Committee recommends:

- That Congress strengthen the capability of the support agencies to undertake analyses regarding policies for science, including the evaluation of issues pertaining to science and technology budgets, personnel, and facilities.

- That Congress ensure that a balance is maintained between the demand for support agency services and the resources available to the agencies to meet this demand. The Committee was particularly troubled by the lack of balance between demand for services and supply of resources at the Congressional Research Service.

- That Congress recognize the importance of institutional memory and technical expertise at the support agencies in an environment in which personal and committee staff turnover on Capitol Hill is rapid. The Committee recommends that Congress support the development of incentives to encourage recruitment and retention of outstanding support agency technical personnel, such as ensuring that salaries are competitive with those of the executive branch; authorizing sabbatical programs; and instituting an awards program to recognize outstanding work by support agency personnel.

- That Congress retain the requirement that the advice and analysis on S&T issues given by the support agencies be nonpartisan.

- That Congress modify Library of Congress personnel policies to allow the Congressional Research Service more flexibility in attracting and retaining

individuals with outstanding credentials in science, technology, and public policy.

- That Congress use a Science and Technology Study Conference or related legislative service organization to aid in the coordination of requests for certain support agency analyses, including parallel or joint analyses by two or more agencies.

- That Congress request analytical assistance from the support agencies, particularly the Office of Technology Assessment, to aid congressional decision making with respect to establishing S&T goals and budget priorities.

- That Congress preserve and expand the opportunity for support agencies to self-initiate certain studies, particularly those designed to anticipate future S&T-related challenges or activities that Congress may wish to develop or support.

- That Congress review the collective S&T capabilities, budgets, and accomplishments of the four support agencies every four to six years to meet the changing needs of legislators and their staff.

Recommendations for Consideration by All Four Support Agencies

The Committee recommends:

- That the support agencies explore approaches to delivering information to Congress and the public more effectively.

- That the support agencies improve their capabilities to analyze international issues with substantial scientific and technological content.

- That the support agencies enhance efforts to communicate and cooperate with one another in the analysis of S&T issues.

Recommendations for Consideration by the Office of Technology Assessment

The Committee finds that OTA assessments are widely used and appreciated by individuals both within and outside Congress. Less technical dis-

cussion and greater attention to policy issues and options, however, would strengthen these reports. The Committee also believes that resource limitations are precluding the expansion of staff capabilities in important analytical areas.

The Committee recommends:

- That OTA preserve and enhance its capabilities for undertaking in-depth nonpartisan assessments of critical S&T issues, including those pertaining to "policy for science." The Committee recommends several modifications and additions to the types of analytical products that OTA offers Congress.

- That OTA inform legislators and the public of the range of opinions it has considered through its advisory and review processes while continuing to take full responsibility for its reports.

- That OTA develop the analytical capability to assist Congress in the S&T priority-setting process, and that the agency develop procedures to assist Senators and Representatives in making such decisions.

- That OTA enhance its capabilities for economic analysis and more frequently integrate economic analyses in its assessment activities.

- That OTA expand its assessment capabilities in the international arena.

- That OTA take steps to assure attraction and retention of outstanding personnel, and take advantage of opportunities to use experts from federal and state agencies on temporary assignment.

- That OTA seek approval of the OTA Technology Assessment Board (TAB) to undertake more discretionary studies, particularly those designed to anticipate future S&T challenges.

- That OTA explore ways to enhance its interactions with other outside organizations, including the White House Office of Science and Technology Policy, state analytical organizations, and academic and nongovernmental organizations, particularly those with programs devoted to technology assessment and science and technology policy.

- That OTA explore new approaches for delivering information to both Congress and the public, and expand the distribution of its reports, especially to state governments.

RECOMMENDATIONS FOR CONSIDERATION BY THE LIBRARY OF CONGRESS AND THE CONGRESSIONAL RESEARCH SERVICE

The Committee finds that the Congressional Research Service and the Library of Congress in general are highly regarded by legislators and their staff as reliable sources of timely scientific and technical information relevant to the immediate needs of Congress. The Committee is concerned that CRS faces shortages of scientific and technical personnel, particularly at the senior levels, at a time when the demand for S&T-related services is steadily increasing.

The Committee recommends:

- That the Library of Congress and the Congressional Research Service act to ensure that, in the effort to maintain and strengthen capabilities for quick-response reference services, S&T analytical capabilities are not weakened.

- That CRS develop a closer working relationship with the National Academy of Sciences complex in order to analyze and comment upon legislative approaches to issues raised in Academy studies.

- That the Library of Congress appoint an expert panel to provide advice and develop a long-term plan on ways to make S&T information readily accessible to users both within and outside Congress.

- That the Library of Congress expand its efforts to link Library collections with those of other nations and to provide American citizens with access to referral information on the availability of scientific and technical information developed in foreign countries.

RECOMMENDATIONS FOR CONSIDERATION BY THE GENERAL ACCOUNTING OFFICE

The Committee finds that scientific and technical staff at GAO is very limited in relation to the mission and size of the organization and the requirements for a balance of expert knowledge in a variety of disciplines.

The Committee recommends:

- That GAO establish an Office of Science and Technology with a director responsible for providing advice and assistance to the Comptroller General

and other senior officials concerning S&T-related studies carried out by the agency.

- That, to assure adequate analytical capabilities in S&T areas, GAO strengthen its technical expertise.

Recommendations for Consideration by the Congressional Budget Office

The Committee finds that, consistent with its mission, CBO has limited responsibilities with respect to science and technology policy and that at the present time, CBO has committed the equivalent of approximately two full-time staff positions to the analysis of S&T-related budget matters. The Committee anticipates that present trends toward more congressional attention to S&T-related budget issues will continue and that this will result in a greater demand for CBO analysis in this area.

The Committee recommends:

- That CBO enhance its capabilities for analysis of the budgetary considerations of S&T programs and proposed initiatives.

- That CBO work with congressional committees, the Office of Technology Assessment, the Congressional Research Service, the Office of Management and Budget (OMB) and the Office of Science and Technology Policy (OSTP) within the Executive Office of the President to consider ways of improving the presentation and analysis of S&T-related budget information.

■ ■ ■

The Committee concludes that the support agencies have built a solid record of achievement, even as demand for information from the agencies has risen and resources have remained steady or have increased modestly. The Committee hopes that Congress will continue to monitor the resource needs of the support agencies and ensure that they have sufficient funds to attract and retain outstanding personnel, operate effectively, and meet the needs of Members and staff. If demand continues to rise and there are no concomitant increases in funding, budget constraints may force the agencies to make difficult operational decisions.

To support the S&T analytical and informational needs of Congress as it addresses critical national needs in the next decade and beyond, the

Committee believes that Congress must maintain the strength and vitality of the four support agencies. The members of the Committee on Science, Technology, and Congress hope that these recommendations will stimulate further discussion of and debate on approaches to strengthening the capacity of Congress to make wise decisions on science and technology policy issues.

1
SCIENCE, TECHNOLOGY, AND CONGRESS

The Carnegie Commission's studies with respect to analysis and advice for Congress have been motivated by the increasing pervasiveness of science and technology (S&T) in congressional decision making and by the desire of legislators to enhance their capabilities to address these issues.[1] Whether supporting science and technology by creating and funding research programs, controlling S&T by regulating some aspects of research, or considering the use of the nation's scientific and technological capabilities to achieve societal goals, Congress is constantly in need of assistance and specialized support from internal and external sources. In this report the Commission presents its findings and recommendations concerning critically important sources of S&T analysis and advice: the Office of Technology Assessment, the Congressional Research Service of the Library of Congress, the General Accounting Office, and the Congressional Budget Office—collectively called the congressional support agencies.

Science and technology present a special challenge to legislators for

several reasons. Few members have substantial training or experience in these fields and accordingly cannot rely solely upon their own knowledge in making decisions. Scientific and technological considerations underlie an enormous range of policy issues from energy and environment to defense and transportation. Science and technology are often aspects of issues rather than issues themselves and are occasionally dismissed mistakenly as tangential considerations.

The task of providing S&T information and analysis to legislators is further complicated by the way Congress works. Congress operates through the efforts of individual Members,* committees and subcommittees, party leaders, personal and committee staff, legislative study organizations and specialized caucuses, and support agencies—all with different areas of concern and all responding to unique sets of incentives and demands from within and outside the legislative branch.

Congress also performs diverse tasks: making substantive policy, allocating budgets, overseeing the implementation of its decisions, evaluating policy, engaging in long-range planning, addressing the needs of constituents, and protecting its constitutional prerogatives. Consequently, Congress must depend on a wide variety of types of information, analysis, and knowledge. Congress must be alerted, informed, and advised about S&T issues in useful and timely ways, then propose responses, create compromises, and establish priorities. The pervasiveness and complexity of S&T issues make Congress partially dependent on analysis and advice from the congressional support agencies.

CONGRESSIONAL RESPONSIBILITIES IN S&T POLICY

> It is the proper duty of a representative body to look diligently into every affair of government and to talk much about what it sees. It is meant to be the eyes and the voice, and to embody the wisdom and will of its constituents. Unless Congress have and use every means of acquainting itself with the acts and the disposition of the administrative agents of the government, the country must be helpless to learn how it is being served.
>
> —Woodrow Wilson, *Congressional Government*, 1885

The policy process in Congress includes a variety of stages—initiation and publicizing, formulation, information gathering, interest aggregation, mobilization, modification, implementation—and each Member, committee, and subcommittee handles each of these tasks differently. The legislative process also encompasses a variety of goals and criteria for "good" science policy. Recommendations for improvements in congressional S&T policy making must recognize that achieving these goals will involve trade-offs.

* Throughout this report "Members" refers to both Senators and Representatives.

Some areas of the S&T enterprise are sufficiently organized and institutionalized to have a well-staffed permanent presence in Washington, but it is increasingly clear that the S&T policy system lacks both comprehensive research brokers (who can distill and interpret the flood of policy research available to Members) and individuals who can articulate the needs and opportunities of emerging or cross-disciplinary fields. Members of Congress have sometimes been able to compensate for these shortfalls through *ad hoc* networks of S&T contacts or with Congressional Fellows, but one staff member or a few advisors cannot represent the entire range of issues encompassed by science and technology. OTA, CRS, GAO, and CBO—the congressional support agencies—are called on to fill this analytical and information gap.

Certainly, Congress cannot and should not rely solely on the scientific and technical information provided by the executive branch. The roles and needs of the two branches are different. To maintain the constitutional balance between branches, to monitor the executive's implementation of statutes, and to preserve relationships with constituencies, Members of Congress must have independent guidance and support on S&T issues. Another factor in this respect is that the White House may submit budgetary or programmatic suggestions to Congress without making the President's priorities clear, leaving it to the legislature to establish them. The inescapable role of Congress is illustrated by the fate of the 1976 National Science and Technology Policy, Organization, and Priorities Act, which included an explicit mandate for the executive branch to coordinate and oversee all federal R&D activities. The White House proved less than enthusiastic about assuming as much of the burden as Congress intended, and the need for S&T analysis has grown, not diminished, in subsequent years.

Congress has been compared to a board of directors; by the time a research budget request gets to the Hill, it has been through a number of management review processes, allowing legislators to fit programs into the total budget but not requiring them to examine every proposal in detail. The challenge for Senators and Representatives remains, however: to know when to delegate or defer, and when to devote their limited time and resources to detailed inquiry and investigation. For these purposes Congress needs its own sources of information and analysis.

THE INFORMATION NEEDS OF CONGRESS

Within the realm of science and technology, decision makers must address a vast range of issues, from considering the need for orbiting X-ray observatories to the feasibility of the Strategic Defense Initiative (SDI) and the

ethical implications of fetal tissue research.[2] There are differences in the sources, quality, availability, and usefulness of information pertinent to each of the major stages of the research and development process: pure basic research, directed basic research, applied research, technology development, and technology commercialization.

With such a diversity of information needs comes an additional layer of complexity. Congress can receive information in a variety of forms: selected or interpreted data; detailed analyses or summaries of data or other analyses; and evaluations and recommendations. Styles and formats sometimes conflict. Attempts to obtain and use large quantities of raw data can get in the way of converting data into useful knowledge; quantity can get in the way of quality and relevance. Data are not information until they are organized and applied. Information is not knowledge until it is understood. And effective communication between Congress and the S&T community requires more than shared information: it demands shared interpretation as well.[3] Viewed this way, the challenge for the support agencies is clear: to be of maximum assistance, the agencies must be able to respond to legislators who may not be familiar enough with the issues to know just what kinds of information and analysis they need. The support agencies also serve Congress by helping to communicate the concerns and interests of legislators to various constituencies, including the S&T community.

The diverse needs and functions of such a complex institution as Congress mean that policy analysis can take many forms. Generally, analysis involves (1) identification and definition of a problem or opportunity confronting a decision maker; (2) the accumulation, organization, and archiving of data relevant to the issue; (3) selection of an appropriate technique for structuring data so they can be related to the goals of the decision maker; and (4) presentation and interpretation of the results of the analysis in a manner that is timely and appropriate to the needs of the decision maker.

GUIDELINES FOR USEFUL INFORMATION AND ANALYSIS FOR CONGRESS

The Commission's findings and recommendations concerning the support agencies are based on several broad principles that the Commission believes characterize useful mechanisms of support.

RESPONSIVENESS

To avoid answering the wrong question, an analyst must be certain that he or she fully understands a request for assistance. The Member or committee

that requests information, analysis, or a thorough study may have a precise need directly relevant to a specific piece of legislation, oversight, or investigation. Yet particularly for S&T policy issues, the request may instead concern an issue that is emerging, in a state of rapid change, or linked to other complex topics. It is often difficult for a Member or committee chairman to know the depth of detail and the scope of the issues to be addressed by the support agency until some additional information is acquired; moreover, the requester may not know what related analyses are already available, under way, or planned. In short, the congressional support agency may need to extend the question, focus it, or tie it to other considerations. The agency must be free to tell Members and committee chairmen that the request is based on erroneous assumptions or that the issue is not sufficiently ripe to allow an answer. Similarly, to maintain a careful balance among congressional forces, to maximize the use of resources, and to consider broader or related issues, an agency must be able to convert a single request into a composite question that responds to the needs—and potential demands—of other committees in both Houses of Congress.[4]

Timing

When a Member or a committee chairman submits a request for information or analysis, the issue may be of pressing concern, requiring, to be useful, a response from the support agency within hours or days, or the issue may be on the frontier of the institutional agenda, ready to be explored and investigated but not legislated. Therefore, the timing of the request must be consistent with congressional needs.

But just as Congress moves in cycles that vary across issue areas, committees, and Members' agendas, so do science and technology advance according to their own schedules. Scientific discoveries do not correspond to the biennial calendar of Congress; the timetables of technology are driven by research capabilities and market pressures, not by electoral cycles. A breakthrough in technology may be of enormous immediate relevance to Congress, but S&T communities may be unable to respond with any confidence or consensus to immediate congressional requests for information about the trajectory and implications of the technology; the "cold fusion" furor in 1989 is an example of this phenomenon. As a result, a request for analysis may be premature. For a support agency to be able to justify declaring that an S&T issue is not ripe for analysis, however, agency staff need background information and a capacity to track the progress of issues before they reach the attention of Congress. Therefore, the support agencies must be granted sufficient resources to nurture their understanding of potential issues and not simply respond to front-page controversies. The long-term tracking of

issues entails the creation in the support agencies of an institutional memory, maintained by steady support for both specialists and generalists.

There are special moments when policy issues reach the top of the congressional agenda, when compromises have been carefully nurtured, and when information and analysis can play a significant role in statutory language and Members' votes.[5] The challenge for legislators is to join an issue and a solution at the time when both are ready.[6] For issues with strong S&T components, Members are unlikely to identify those opportunities without close working relationships with experts who are aware of both congressional agendas and the evolution of scientific and technological progress.

PRESENTATION

The formats in which support agencies present their findings to Members or committees vary widely: formal testimony, prerelease briefings, informal conversations with staff or Members, full reports, executive summaries, and so on. Each format has advantages and disadvantages. For example, a quick and informal discussion of interim findings may be exactly what a requester needs (and may avoid surprising the requester with an unanticipated set of findings that may conflict with a legislative position or strategy), but there is a risk of bias or incompleteness. Given the specialized nature of S&T information and analysis, support agencies must also be careful to interpret clearly the technical complexities of their studies.

BALANCE

In general, there are two ways to achieve balance in analysis and advice. The first is to provide no recommendations, thereby avoiding the possibility of partisan or ideological bias. Analysts in the support agencies could simply present "the facts" and allow Members of Congress to draw their own conclusions. This approach would, however, be difficult because there is often substantial disagreement as to the nature of fundamental "facts." Analysts are rarely totally unbiased in their selection of facts, approaches, and findings, and Members feel that such a timid and limited approach would not present them with a full understanding of options and their implications. Support agencies must consider whether all Members of Congress should find every sentence of a report acceptable or whether it is more useful for each Member to find at least parts of each study to be helpful.

The second approach to achieving balance is for a support agency to offer competing expert views and analytical approaches, allowing Mem-

bers to consider the validity and relevance of each. An open cross-examination of contradictory findings and recommendations could, even if they did not offer consensus, at least identify areas of agreement and disagreement.[7] But importing this approach to policy analysis into Congress has its drawbacks: "The common training, experience, and professional peer-group pressure that might serve to constrain analytical claims are lacking,"[8] and Members often would find it difficult to discern the strengths and weaknesses of each argument.

CONTEXT

The ultimate challenge for Congress on scientific and technical matters is to obtain S&T information and analysis in a timely and coherent fashion, and in a context linked to the many non-S&T considerations (such as budget constraints, competing demands, and legislative strategies) that are the basis for congressional action. Members require "research brokers" who "scan the works of academia and other sources of research, bring in that which might be useful in resolving congressional policy dilemmas, fill in gaps that might exist, and adapt it all for use in the congressional environment."[9] The support agencies cannot be simple collectors and disseminators of technical data; they, and others, must serve as research brokers helping Members relate S&T information and analysis to their broader concerns.

Under unique mandates, each support agency has developed organizational structures and processes to respond to the needs of Members and committees.

2

S&T ANALYSIS AND ADVICE FOR CONGRESS: THE MISSIONS OF THE SUPPORT AGENCIES

Congress can obtain information, advice, and analysis about science and technology issues from many external sources. Members can also seek assistance from personal and committee staff, legislative conferences and study organizations, and each other.

The roles of OTA, CRS, GAO, and CBO are complex because they must both catalyze and capitalize on the diverse sources of information and analysis that exist within and outside Congress. In doing so, the support agencies demarcate a special niche in the congressional system. They must help sort and evaluate the flood of information that may overwhelm Members—in short, serving as "information brokers," bridging the divisions created by committee jurisdictions and agency missions, and providing a unique type of institutional memory that spans the tenure of Members and their staffs.

The support agencies have achieved relatively comfortable formal and informal working relations with each other, usually avoiding significant

overlap and duplication of effort. They are distinctively different institutions with different personnel, policies, and roles. Committees and individual Senators and Representatives have different needs and perspectives, and they benefit by having access to a variety of opinions from different perspectives.

Congress must continue to find ways of encouraging the support agency system to evolve in response to congressional needs. The proper response of the agencies is not, however, always obvious. For example, it is not clear that the four support agencies as currently comprised are well suited to assist Congress in meeting one of its greatest challenges in making policy for supporting science: how to establish priorities for research funding among and within scientific disciplines. Members report that they need assistance from the support agencies and the scientific community in evaluating priorities. There are, however, currently no generally accepted theories or methods for making predictions about the long-term payoffs from "big science" projects or from small individual investigator grants. The blind alleys that must be explored, the unexpected breakthroughs, the interactions among fields, the field-specific factors that contribute to progress in one discipline but not others, and the cumulative nature of knowledge are all part of an enterprise that no one can comprehend or plan completely.

The support agencies have been adept in preserving their cautious approach to analysis and have successfully resisted the temptation to promise more certainty or precision than they can deliver. However, as the following reviews of the four support agencies indicate, there are areas in which they can, without jeopardizing their strengths, improve their usefulness to Congress.

THE OFFICE OF TECHNOLOGY ASSESSMENT

The Office of Technology Assessment was created by the Technology Assessment Act of 1972, which was based on the premise that Congress needed to "equip itself with new and effective means for securing competent, unbiased information concerning the physical, biological, economic, social, and political effects" of the applications of technology. This information was to include "early indications" of the impacts of technology, "cause and effect relationships," and "alternative technological methods" of achieving specific goals.[10]

OTA is overseen by the Technology Assessment Board (TAB), which is composed of six members from the House and six from the Senate, appointed by the leadership of each chamber, equally divided by party. The TAB is credited with insulating OTA from politicization while sustaining its relevance to Congress. OTA also has a 12-member Technology Assess-

ment Advisory Council (TAAC), consisting of 10 members from the public appointed by the TAB, the Comptroller General of GAO, and the Director of CRS. TAAC provides OTA with broad guidance on future directions, but it meets only twice a year, and its members have had little direct influence on the agency's programs. Guidance on individual projects is provided by *ad hoc* advisory panels, usually composed of 15 to 20 experts (about two-thirds nonacademic) carefully selected to represent a wide range of concerns and perspectives; these advisory panels are considered essential to OTA's efforts to identify correctly core issues in OTA studies.

OTA received its first funding in November 1973, began operations in January 1974, and produced its first report (*Drug Bioequivalence*) in July 1974. In FY 1991 OTA had a budget of $19.5 million and 143 staff positions, as well as a substantial number of temporary employees, in-house contractors, and detailees from executive branch agencies. About half the research staff hold PhD, JD, or MD degrees.

Most OTA studies are produced for the House Committee on Energy and Commerce; the House Committee on Science, Space, and Technology; and the Senate Committee on Commerce, Science, and Transportation, which have provided more than 200 requests to OTA. The range of OTA's assistance is broader, however: nine committees of the House and nine of the Senate have requested 10 or more studies each.[11] The principal consumers of OTA's products are congressional staff members, whose intermediary role between OTA and Members serves several useful functions. Congressional staff provide opportunities for interim feedback to sharpen questions and maximize relevance, they heighten OTA's awareness of the nuances of the legislative process (e.g., schedules, political agendas) to which it must be sensitive, and they have become part of a relationship of confidentiality and trust between Congress and OTA that has been crucial to the agency's progress.[12] OTA is a resource shared by the committees of both Houses, and its work is strictly bipartisan. Multiple committee requests for a particular study help OTA avoid the "single client" bias and broaden the scope of questions to include issues Members may not have considered when shaping their requests for studies. By expanding the range of requesters, OTA helps integrate the perspectives of multiple committees with different agendas, jurisdictions, and political orientations. This process results in products that help committees operate from a common frame of reference.[13]

OTA responds to congressional needs with different products. The agency provides informal briefings, formal presentations, working papers, raw data, testimony, interim reports, staff papers, and videotape presentations. In particular, OTA has made an effort to provide shorter, better organized, and more readable products as well as to train staff for more effective written and oral presentations.

Although there was some criticism of OTA during its early years, over the past decade the agency has garnered widespread recognition and respect for the quality of its staff, procedures, and products. As a European observer said, "Because of the reputation of OTA, technology assessment has come to mean essentially whatever it is that OTA does."[14]

The successes of OTA can, however, threaten its future potential: as the demand for studies continues to grow, the agency's workload will expand, making it more difficult to combine and filter requests—a tendency that could threaten the self-initiated, anticipatory component of OTA's responsibility in favor of specific requests of more immediate utility. In like fashion, the agency, because of its perceived utility, will face pressures to expand, and with increase in size can come greater organizational differentiation. Given the wide and complex range of issues that OTA confronts, organization into only three divisions[15] helps the agency avoid overspecialization.

OTA itself expects to be drawn more and more into debate about the costs of medical technology, the roots of technological lethargy and its contribution to America's trade problems, the role of human resources in our technology base, and international scientific and technical issues.[16] At some point, organizational changes may become necessary to meet evolving congressional information and analytical needs.

THE CONGRESSIONAL RESEARCH SERVICE

Established in 1914, the Legislative Reference Service (LRS) of the Library of Congress was assigned additional responsibilities in the Legislative Reorganization Act of 1946: to provide analysis and information and to undertake research to assist Congress in carrying out its legislative and representative duties. LRS was given separate status in the Library and was authorized to hire senior specialists, at pay levels comparable to equivalent positions in the executive branch, to focus on particular subjects.

Amendments to the Act in 1970 changed the name of LRS to the Congressional Research Service and required it to assist and advise committees in the analysis, appraisal, and evaluation of legislative proposals and in the measurement of the effects of alternative proposals. This expanded mandate augured the tripling of CRS's staff during the 1970s and reflected recognition by Congress that it needed more than a reference service. In 1964 the Science Policy Research Division (SPRD) was formed within the LRS. Today the CRS includes two information and reference divisions and seven policy analysis divisions; two of these divisions (SPRD and Environ-

ment and Natural Resources Policy) focus most of their attention on S&T issues, although others (Economic, Education, and Public Welfare) also address these issues to varying extents.

About 61 percent of the permanent positions in CRS are in policy analysis; nearly one-third of the total research staff have PhDs. These personnel have been encouraged to envision CRS not solely as a reference service but as a congressional "think tank" as well. The agency has sometimes played an active role in the formulation of science policy proposals, with CRS staff working with congressional staff to draft legislation. CRS may alert Members and committees about issues on the horizon, and the agency has developed "analytic frameworks" for congressional policy development that seek to reduce the number and complexity of issues Congress will consider.[17] CRS does not, however, make recommendations about the congressional agenda or about specific courses of action.

Unlike OTA's policy of widespread dissemination of its interim and final reports, CRS is prohibited from publishing its reports or studies for noncongressional use. As the only support agency that allows Members to keep certain information requests confidential, CRS is protected by its proprietary relationship with Congress. The agency also differs from OTA insofar as its studies are not, because of time constraints and restrictions on its openness, subject to peer review. For most of CRS's duties this is not a significant problem, but if Congress decides to request more long-range and in-depth studies from the agency, outside review would be highly desirable.

The workload of CRS reflects the demands on its time and resources. In 1989, the entire CRS responded to more than 500,000 requests, and in two-thirds of these cases response time was less than a day.[18] Individual Members of Congress account for about three-fifths of all inquiries, but these require only about one-third of the agency's time. Committee requests provide about one-fifth of the CRS workload but consume more than one-third of its time. And although forward-looking, anticipatory studies account for only about one percent of the inquiries to CRS, the agency devotes nearly one-fourth of its time to these studies. At the beginning of the 100th Congress, CRS began a Major Issues Planning System to anticipate problems for the next Congress; senior managers meet twice a year and identify approximately 20 issues that are likely to be major topics in the legislature.[19] CRS has developed a variety of formulas for presenting its information and analyses to Congress, including reports, in-depth analyses, seminars for Members and staff, issue briefs, audio and video briefs and programs, and individual, in-person briefings.[20]

In recent years several trends have been alleged to be limiting the ability of CRS to fulfill its mandate. Increases in the number of quick-response,

factual S&T-related information requests, coupled with declines in funds for staff positions, have created pressure on the agency to devote fewer resources to technical and complex policy analyses. With the budgetary problems at CRS in recent years, and particularly with the loss of key senior personnel in the Science Policy Research Division, it is becoming increasingly difficult for CRS to maintain the traditional quality of its work.

THE GENERAL ACCOUNTING OFFICE

Created in 1921, the General Accounting Office began its relationship with Congress on a rather distant basis, but under reforms initiated in 1946, GAO was given increasing responsibility for going beyond descriptions of the legality of government management to analyze its effectiveness. In the late 1960s, Congress instructed GAO to develop capabilities in program evaluation, and the 1970 Legislative Reorganization Act and the 1974 Congressional Budget and Impoundment Control Act pushed GAO further in this direction. In 1976, the Program Analysis Division was created, and in 1980 the Institute for Program Evaluation (now called the Program Evaluation and Methodology Division) was formed to keep GAO on the "cutting edge" of new evaluation technologies. Now, all GAO divisions routinely undertake these evaluations. During the same period, Comptroller General Elmer Staats reorganized GAO's operating divisions into eight units "deliberately designed to cross organizational lines within the government; many were in fact government-wide."[21] Title VIII of the 1974 Congressional Budget and Impoundment Control Act prompted GAO to develop a unified, objective-oriented budget classification system that would provide information on all federal R&D activities; the purpose was to allow Congress and the executive branch to relate federal R&D allocations to specific problems and objectives. Furthermore, under Staats, GAO moved toward a closer relationship with Congress; the proportion of reports begun at the request of Congress tripled (to about one-third) during his tenure; many others were begun by GAO in anticipation of congressional needs as a result of its closer working relationship with Members and their staffs. GAO also began lending staff to work with congressional committees in drafting legislation, briefing Members and staff on studies in progress, and preparing for committee hearings.[22]

The proportion of reports prepared at the request of Congress has continued to grow. Over the last four years, GAO has devoted more than 80 percent of its annual audit staff-years to congressional requests, primarily for committee and subcommittee chairmen or ranking minority Members.

GAO has established a long-term dialogue with committee staff that helps to guide committee requests.

GAO might be expected to have some advantages over OTA, CBO, and CRS because of its independence (the Comptroller General serves one 15-year term, and the agency has statutory powers that allow it access to the executive branch); size (about four times the staff of the other support agencies combined); geographical reach (an array of field offices in the United States and abroad); and great flexibility in the choice of projects. GAO can also make specific recommendations in its reports. Nevertheless, GAO suffers from a number of real or perceived shortcomings.[23]

Some GAO watchers have expressed concern that the agency displays a tendency to answer precisely the questions it is asked, thereby providing an incentive for requesters to shape requests carefully so that a study will support a desired political position. However, GAO has also been criticized for occasional timidity in avoiding the expansion of a Member's or committee's question, and in drawing attention to its implications or shortcomings for fear of appearing to be political.

In 1972, GAO identified S&T as an issue area deserving a separate staff (fewer than 25) capable of producing both responses to congressional inquiries and self-initiated studies. During the mid-1980s, S&T policy was downgraded from an issue area (because it required less than 25 staff-years of effort) to an "area of interest," and in 1988 the agency dropped science and technology policy from even that category.[24] There is now no office in GAO dedicated to broad S&T policy analysis, and the agency no longer prepares a long-range plan for S&T issues that could alert members and committees to GAO's potential role in the area.

It should not be concluded that GAO shuns S&T policy-related activities. Scientific and technical issues are components of many of its studies; nonetheless, few GAO personnel have scientific and technical expertise, a factor that can limit the scope and quality of some reports. Although GAO continues to respond to congressional inquiries about S&T policy, it does so primarily through its Resources, Community and Economic Development Division (RCED), which also acts as a liaison with the House and Senate science committees. In addition, GAO addresses scientific and technical issues as part of its work in other divisions and issue areas. For example, the National Security and International Affairs Division and the Program Evaluation and Methodology Division often address S&T-related issues as part of their evaluations.

Any attempt to strengthen GAO's role in S&T policy analysis for Congress must be sensitive to the unique role of each support agency and to unnecessary overlap and duplication among the four agencies. In the case of GAO, the danger of confusion is reduced because the Comptroller Gen-

eral is a member of OTA's Technology Assessment Advisory Council. Also, formal and informal mechanisms exist that allow each agency to be aware of the work of others. However, the GAO has specialized capabilities for policy analysis (e.g., its national and international field offices, its nimbleness and speed, and its access to resources) that give it unique advantages in providing S&T policy support to Congress.

THE CONGRESSIONAL BUDGET OFFICE

Created in 1974 to compensate for the analytical and informational imbalance created by the Office of Management and Budget in the executive branch, CBO fulfills a highly specialized need for Congress. CBO projects the cost of current and proposed programs, forecasts the effects of budget proposals on the economy, and estimates the impact of the economy on the budget.[25]

CBO is required to respond first to requests from the budget committees, then from the appropriations, taxing, and authorizing committees, leaving it little time to deal with requests from individual Members. Nearly half of the approximately 165 professional analysts at CBO are assigned to budget analysis—about four times the number dedicated to either natural resources or national security program analysis; none, however, has graduate-level training in the natural sciences. CBO makes recommendations only when directed by statute, and then usually only when such recommendations relate to technical judgments and not policy priorities. CBO reports are widely available to the public, usually after both internal and external review.

Members of Congress are well aware that scientific research and technological development play a critical role in economic growth and that public funding of S&T is partially responsible for the nation's economic strength. As a result, Congress periodically requests analyses that examine the relationships among science, technology, the economy, and the national budget. Although CBO receives high marks for its budget analyses,[26] few Members and staff consider CBO a primary resource for assistance with S&T issues.

GOALS OF THIS STUDY

There is a national consensus that the federal government should support science and that science plays a critical role in achieving societal goals. The

assumption commonly made is that science is neutral, that it precedes technological applications, and that it can be assessed only by practitioners.

Although this relatively apolitical or nonideological perspective on science is reassuring to many, it leaves Congress in need of other criteria by which to choose between science and other priorities, and among science policy proposals. Congressional budget decisions are based on a range of concerns that go well beyond scientific merit. In science policy as in technology policy, the challenge for those who provide support to Congress is to fulfill the responsibility noted by OTA's director: to "produce reports identifying where consensus on an [S&T] issue exists, explaining the reasons for disagreements among the experts, and suggesting plausible options for federal action."[27]

Technological advancement supports the objectives and missions of federal agencies and aids in the implementation of federal policies. There is not a consensus in Congress about the role of the government in stimulating technology—about the point in the development and commercialization process at which government assistance or direction becomes detrimental rather than advantageous. Technology policy raises concerns about industrial policy, subsidies for targeted industries, and the potential to confuse proper functions of the public and private sectors. The congressional support agencies have excelled at not allowing their contributions to be limited by such disputes. Nonetheless, as the nation's economic competitiveness continues to be tied more closely to its S&T policies, there is a danger that the support agencies will be drawn into the controversy. Furthermore, as Members of Congress become less likely to endorse public expenditures for knowledge alone than for knowledge with a mission, there is a need for analysis that reveals to Members both the potentials and the uncertainties linking basic research to a possible application that promotes the national interest.[28]

Is Congress prepared for the challenges that science and technology will pose during the next decade and beyond? To the degree that new demands and opportunities for the legislature can be reasonably anticipated, one of Congress's greatest assets in this task is the diversity of the support agencies. We have identified the basic strengths and weaknesses of OTA, CRS, GAO, and CBO. Our report now turns to general findings and to recommendations intended to ensure that the support agencies have the capability to meet the anticipated needs of Congress for S&T-related analysis and advice in the years ahead.

3
ENHANCING SUPPORT AGENCY ACTIVITIES: FINDINGS AND RECOMMENDATIONS

As part of its examination of the advisory and analytical role of the congressional support agencies, the Commission's Committee on Science, Technology, and Congress has had extensive discussions with Senators and Representatives and their staff, the requesters and primary users of information developed by the support agencies; with the managers and staff of the support agencies themselves; and with academic experts and others outside Congress who are familiar with the support agencies and make use of their products.

Congress has a long-standing interest in the viability of the congressional support agencies and has periodically identified ways to enhance their activities and their institutional relationship with Members. In 1976, for example, the Commission on the Operation of the Senate recommended that the Senate "enhance its supervision of congressional support agencies . . . to improve their administration, ensure cooperation among them, and improve their analytic services."[29]

It is evident that over the years Members of Congress and their staff have developed a high regard for the work of the support agencies and consider their missions critical to furthering the legislative process. Yet Members and staff also acknowledge that the congressional agenda is in a continuous state of evolution and that the missions of the support agencies must also evolve if they are to continue to provide high-quality services that will meet the future needs of Congress. Members and staff also point to opportunities for improvement in certain agency policies and activities. Resource issues are among the major congressional concerns as Members seek to limit increases in legislative branch expenditures while at the same time assuring that the support agencies have sufficient operating funds to provide essential services.

As stated in the earlier sections of this report and in the Commission's previous report, *Science, Technology, and Congress: Expert Advice and the Decision-Making Process*, Congress is flooded—indeed, frequently overwhelmed—with information and advice from a wide variety of sources. The support agencies are often called on to sort through this wealth of information and to bring the essential, most relevant facts to the attention of Members and staff. As discussed in the first report, Members and staff seek analysis, advice, and information from numerous sources—the National Academy of Sciences, professional societies, think tanks, individual experts, and others. Therefore, it is in the interest of the support agencies to be vigilant in critically evaluating their own contributions to the legislative process.

Each support agency occupies a unique functional niche, contributing specialized information products to Members and their staff. Congressional needs for information change, however, and the agencies must retain the flexibility to adapt to an uncertain future, one in which science and technology will figure prominently in the debate on a broad range of public policy issues.

The sections that follow are devoted to the Committee's findings and recommendations with respect to the four congressional support agencies. First, the Committee presents its general findings, followed by recommendations to Congress and to the supporting agencies collectively. Next, findings and recommendations specific to each of the support agencies are offered.

GENERAL FINDINGS OF THE COMMITTEE

The Committee's study of the congressional support agencies has resulted in four principal findings that form the foundation for the Committee's recommendations.

■ **The Committee finds that the support agencies perform a critical role in the development of science and technology policy by evaluating issues, translating technical information, and describing alternative courses of action. Although there is some overlap, each agency has developed its own niche, serving an essential analytical and advisory function.**

The resources that each of the support agencies devote exclusively to S&T vary considerably (Tables 1 and 2). Of the four agencies, only the *Office of Technology Assessment* dedicates all of its attention to science and technology policy issues; over the last 10 years, OTA has built a solid reputation for in-depth analysis of major issues. OTA's analytical strength lies in its full-scale assessments, which take 18 to 24 months to complete and are aided by advisory panels of distinguished experts from outside the federal government.

Table 1. Resources Devoted to S&T-Related Analysis in the Congressional Support Agencies (FY 1990)[a]

Agency	Annual S&T Budget ($1,000)	Total Annual Budget ($1,000)	S&T as % of Total Budget	Staff Devoted to S&T (full-time equivalents)	Total Staff (full-time equivalents)	% of Total Staff
OTA	18,571	18,571	100	143	143	100
CRS	6,000	45,821	12.3	83	780	10.7
SPRD[b]	3,000	3,000	—	38	38	—
ENRPD[c]	3,000	3,000	—	45	45	—
GAO[d]	900[d]	358,000	0.3	10 (300)[d]	5,077[e]	0.2 (0.6)
CBO[f]	200	18,336	1.1	2	226	0.9

[a] Numbers are exact where possible, otherwise a nearest estimate.
[b] Science Policy Research Division.
[c] Environment and Natural Resources Policy Division.
[d] GAO devotes considerable attention to S&T issues as components of broader issues. The $900,000 and 10 FTE figures are based on studies which focus largely or exclusively on scientific or technical concerns (these are primarily undertaken in the Resources, Community, and Economic Development Division). GAO estimates that it devotes a total of 300 staff-years to S&T-related issues in a broad range of studies. Depending upon how one defines "S&T-related" studies, estimates of annual expenditures in this area can vary widely and could be substantially higher than $900,000.
[e] This figure is in "staff-years" as distinguished from "full-time equivalents."
[f] These figures are based on work performed in CBO's Natural Resources and Commerce Division.

Table 2. Educational Background of Professionals Working on S&T Issues at the Congressional Support Agencies[a]

	BA		MA		PhD, MD, JD		Total	
Agency	Nat.	Soc.	Nat.	Soc.	Nat.	Soc.	Nat.	Soc.
OTA[b]	9	41	7	36	32	25	48	102
CRS	11	10	8	18	9	13	28	41
SPRD	9	4	5	5	7	2	21	11
ENRPD	2	6	3	13	2	11	7	30
GAO[c]	0	5	1	4	0	0	1	9
CBO[d]	0	0	0	0	0	2	0	2

[a] The totals are based on the highest degree attained by an individual. The degrees have been subdivided roughly as follows: Nat. = natural sciences, including biological, physical, and chemical sciences, environmental sciences, medical sciences, earth sciences, engineering; Soc. = social sciences, including humanities, public policy, economics, political science, business, library sciences, and sociology.
[b] Includes temporary appointments and Congressional Fellows.
[c] These numbers are based on personnel within GAO's Resources, Community, and Economic Development Division. They were provided by RCED.
[d] These estimates were provided by CBO staff.

The *Congressional Research Service* and, more broadly, the Library of Congress are most often looked to for rapid-turnaround responses to scientific and technical questions. CRS is also a source for developing and analyzing legislative proposals, policy research, and longer-term studies of a range of issues. Unlike OTA, which undertakes studies at the request of committee chairs and makes its studies public (with the exception of classified studies related to national security), CRS may carry out analyses for individual Senators and Representatives, who may choose to keep the resulting information confidential. CRS plays an essential role in assuring that Members and staff have the information they need to carry out their daily and near-term legislative responsibilities.

The *General Accounting Office* undertakes analyses and investigations at the request of individual Senators and Representatives or committees. GAO's strength lies in the evaluation of federal programs and policies and the extent to which the executive departments and agencies comply with federal laws and congressional mandates in implementing them. Ordinarily, GAO analyses are retrospective, evaluating the effectiveness of federal programs and suggesting areas for improvement. Unlike the other support agencies, GAO has field offices in regions throughout the United States and

in several foreign countries, allowing it to mobilize staff quickly to investigate national and international policy issues.

The *Congressional Budget Office*'s principal mission is to support the budget and appropriations committees by articulating, analyzing, and evaluating budgetary questions. CBO does, however, periodically undertake analyses of resource issues associated with specific S&T programs.

■ **The Committee finds that the congressional support agencies serve as an important reservoir of institutional memory, providing intellectual continuity in a rapidly changing political environment.**

Because of its constitutional responsibilities and the diverse interests of its members, Congress addresses a vast range of policy issues, most of which have some scientific dimension. The struggle on the part of individual Senators and Representatives to pursue their agendas amidst many other competing demands allows Members and staff few opportunities to focus attention on a particular issue. It is especially difficult for legislators to develop expertise on a subject when they are faced with the daily necessity to make decisions about pending votes, participate in committee activities, and respond to constituent concerns. At the same time, personal and committee staff turnover is high, and personal staff, in particular, often have limited scientific and technical expertise.

To varying degrees, the support agencies are insulated from the more immediate, daily pressures of Congress. Support agency staff, particularly those at OTA, have the opportunity to focus on a small number of issues for an extended period of time. In some instances, individuals have assisted in the development of original legislation and have participated for several years in reauthorization activities. For example, an OTA senior analyst on air quality provided expert advice to both parties in both Houses over an eight-year period until the Clean Air Act was reauthorized in 1990. In addition, several senior staff at CRS have established reputations as leading analysts in key areas of science policy. In this sense, the support agencies offer continuity of specialized expertise in a congressional environment that is in a constant state of change. The Committee believes this form of institutional memory is a valuable intellectual asset and should be preserved, enhanced, and, wherever possible, applied.

■ **The Committee finds that resources available to the support agencies have not kept pace with the rising demand for information; hence, agency activities are increasingly constrained. Since the demand for support agency services will undoubtedly continue to rise through the next decade, either Congress must allow the support agencies more flexibility in prioritizing requests—including declining requests to undertake studies—or, if it in-**

tends to rely on these organizations for technical information of quality, it must provide additional resources.

In recent years, the Science Policy Research Division of the Congressional Research Service has been unable to fill senior-level position vacancies because of a lack of funds. The Office of Technology Assessment has operated with 143 permanent positions since 1987 with only modest budget increases. At the same time, the demand for services in both organizations has steadily increased. The Committee is concerned that congressional efforts to control legislative branch expenditures are placing undue stresses on the support agencies, thereby jeopardizing their capacity to provide critical services to Congress.

■ **The Committee finds that the globalization of science and technology issues has more and more driven Congress into the international arena. Although the support agencies have, to some degree, responded to this trend, it will be necessary to strengthen support agency operations in order to meet increasing congressional requests for internationally oriented scientific and technical information, analysis, and advice.**

The Committee believes the support agencies should be organized and staffed so that they can address science and technology issues from both national *and* international perspectives. This includes the capability to help Congress assess international and foreign policy issues with scientific and technical components.

The world of today is very different from the world of 40, or even 20, years ago, largely because of remarkable scientific and technical advances. Nations are increasingly linked through common economic, political, social, scientific, and environmental objectives. The economic health of the United States depends upon trade, foreign investment, and other factors such as energy supplies. The world's financial markets are connected through instant telecommunications. Democratic movements in Eastern Europe and elsewhere have led to cooperative approaches to solving problems of mutual interest. And international concerns are gradually replacing national concerns on the environmental agenda. In the 1970s, for example, the environmental protection movement in the United States focused on clean air and water, primarily in the nation's urban areas. Today, our objectives encompass global climate change, stratospheric ozone depletion, acid rain, and sustainable development—problems that cannot be solved without the cooperation of both industrialized and developing nations throughout the world. To address global problems, Congress has had to change its agenda, and the support agencies will, therefore, be increasingly called on to assist in the evaluation of the scientific and technological aspects of such issues.

RECOMMENDATIONS TO CONGRESS

Maintaining and improving the analytical capabilities of the congressional support agencies will require specific actions on the part of both Congress and the individual agencies. The Committee has developed several sets of recommendations. The first set is related to Congress itself—the Senators, Representatives, and staff who are the requesters and primary users of the information developed by these agencies. The remaining four sets of recommendations are addressed to the support agencies and their managers and staff. In developing its recommendations, the Committee was cognizant of the desire of Congress to enhance the analytical capabilities of the support agencies while avoiding substantial increases in expenditures.

In the early stages of its analysis, the Committee considered organizational changes as one means of strengthening support agency activities, but the Committee concluded that the current organizational framework serves Congress well.* The recommendations that follow, therefore, aim to enhance the capacity of the support agencies to analyze scientific and technical issues within the present general organizational framework.

■ **The Committee recommends that Congress strengthen the capability of the support agencies to undertake analyses regarding policies for science, including the evaluation of issues pertaining to science and technology budgets, personnel, and facilities.**

Most of the S&T-related work of the congressional support agencies focuses on "science for policy," the contribution of science to the many important issues facing Congress, including environmental protection, national security, and public health. Relatively little work is devoted to "policy for science," issues related to the scientific enterprise itself. How can "big science" projects such as the superconducting super collider and the human genome project be funded without threatening the "little science," the individual research projects that have been responsible for so many of the great scientific achievements to date? To what extent should the federal government support the building and maintenance of research facilities, and how can funds for such facilities be equitably distributed? How can the nation assure an adequate number of scientists and engineers to carry out our research and development needs of the future? How can education policies be modified to improve mathematics and science education in the K–12 grades?

These fundamental questions are likely to remain a priority on the congressional agenda for years to come. Since the Science Policy Research

* Congress itself is considering organizational and procedural changes that could have implications for the support agencies.

Division was organized in 1964, CRS has periodically provided Congress studies of such issues. Recent examples include reports on the White House Office of Science and Technology Policy, science and mathematics education, and basic research policies of Japan. OTA recently made an important contribution in the policy for science arena with its report *Federally Funded Research: Decisions for a Decade*,[30] which addresses a wide range of fundamental policy issues.

The Committee believes that all four of the congressional support agencies, the Office of Technology Assessment in particular, should be provided with additional resources to enable them to give more attention to broad "policy for science" issues. A bipartisan Congressional Science and Technology Study Conference, as recommended in the Committee's first report, could help legislators and their staff direct studies of this kind to the support agencies.[31]

■ **The Committee recommends that Congress ensure that a balance is maintained between the demand for support agency services and the resources available to the agencies to meet this demand.**

The lack of a one-to-one correspondence between demand for services and the supply of resources is especially troubling at the Congressional Research Service, where, until recently, senior science policy positions remained vacant. As congressional requests for analytical services and information from CRS, OTA, and GAO continue to increase, Congress will have to match resources better with demand to ensure that its needs are met and that the support agencies continue to produce quality products.

Because of resource constraints, in recent years OTA has had to cut back its use of outside experts through contract mechanisms. In a period of tight budgets, OTA has made in-house staff its highest priority; consequently, OTA now expends 20 to 30 percent of a project budget on contracts, down from 40 to 50 percent in the mid-1980s.[13]

■ **The Committee recommends that Congress recognize the importance of institutional memory and technical expertise at the support agencies in an environment in which personal and committee staff turnover on Capitol Hill is rapid. Congress should support the development of incentives to encourage recruitment and retention of outstanding support agency technical personnel.**

Opportunities for professional advancement in the support agencies, particularly in OTA and CRS, are at present very limited. The relatively small size of these agencies is one reason for this phenomenon. In addition, salaries and benefits are not competitive with those of the executive branch or private sector. Moreover, there are constraints on earning outside income

from other sources. These fundamental characteristics can make attracting and retaining the "best and brightest" a challenge, particularly for scientists and engineers and others whose status among their peers is measured in terms of quantity and quality of publications and a high profile at scientific meetings and elsewhere.

Despite these drawbacks, the support agencies attract outstanding individuals, many of whom are willing to trade away careers in research and teaching for the opportunity to participate directly in and influence the legislative process. Retaining such people is important in an institution in which personal staff tenure averages only three years. For example, in the House of Representatives personal staff tenure dropped in 1990 from 3.4 years in 1987 to 2.9 years in 1990.[32]

The support agencies offer the opportunity for stability of expertise in a fluid professional environment. They are reservoirs of institutional memory and a source of a wealth of technical expertise. The Committee encourages Congress to maintain its capability to draw on the specialized expertise of experienced technical staff members who can devote the time necessary for thoughtful evaluation of policy options.

Congress could take several actions to improve the incentives for accepting and remaining in a position, short-term or long-term, in the congressional support agencies. Congress could ensure that employee salaries are competitive with those of the executive branch and could authorize sabbatical programs to permit individuals who have served Congress for a number of years to spend 6 to 12 months in academic positions, with nongovernmental organizations, or elsewhere to develop their professional skills and share their experiences with others.

Congress could also institute an annual awards program to recognize an outstanding report or other product prepared by a group of staff or exemplary performance on the part of an individual. Such a program would require relatively little effort on the part of Congress and could be administered through a Science and Technology Study Conference or Institute, a related legislative service organization, or through a Senate or House Committee.

■ **The Committee recommends that Congress modify Library of Congress personnel policies to allow the Congressional Research Service more flexibility in attracting and retaining individuals with outstanding credentials in science, technology, and public policy.**

The Congressional Research Service operates under a personnel system similar to the General Service (GS) system used by the executive branch of the federal government until 1978. The Civil Service Reform Act of 1978 resulted in extensive changes in the executive branch system; however, these

changes were not adopted by CRS. Cumbersome personnel procedures have made it difficult for CRS to compete for outstanding individuals, and the best applicants for CRS vacancies are occasionally lost because of the length of time taken up by the selection process.[33]

The Committee recommends that Congress consider modifying CRS personnel policies to allow more flexibility in hiring decisions. One approach to employing highly qualified young scientists and engineers is actively to seek Fellows under the Scientist and Engineers Congressional Fellows Program. CRS could consider developing a program in conjunction with OTA to allow direct hiring of Fellows on a temporary basis.

Since 1985, 14 midlevel and senior staff in the Science Policy Research Division and the Environmental and Natural Resources Policy Division have resigned or retired. A number of those who left indicated that inadequate support for staff professional development was an important factor in their decision to seek employment elsewhere. Travel to professional conferences has been curtailed, funds for registration fees are very limited, and sabbatical assignments unlikely. As of February 1991, 9 of these 14 positions remained vacant.[33] The result has been a substantial additional burden on the remaining staff, most of whom are junior to those who have left the organization. The Library of Congress recently instituted a new, more competitive salary scale for senior personnel that should help attract and retain individuals at this level.

Nevertheless, the Committee is concerned that hiring freezes, rigid personnel policies, budget constraints, and changes in the composition of CRS staff are threatening the agency's ability to meet congressional analytical needs in the science and technology area. The Committee urges Congress to encourage CRS to develop policies and take further action to maintain and strengthen its staff resources.

■ **The Committee recommends that Congress preserve the nonpartisan nature of the analysis of S&T issues by the support agencies.**

Trust is the key to access to Members of Congress and their staff. The support agencies have built a close relationship with legislators and their staff because of the quality and political neutrality of information that they have provided over the years. Because most information developed by the support agencies is directed to Congress as a whole, it must be politically balanced and nonpartisan in nature. There is occasionally a place for partisan analysis and advice—CRS, for example, does help develop legislative initiatives for individual Members and committees—but such advice should be clearly labeled as such so as not to be confused with the nonpartisan analysis central to the missions of the support agencies.

Members and their staff feel that support agency products are gen-

erally free of bias. If they maintain their objectivity by taking into account alternative political perspectives, the support agencies can avoid undermining their relationship with Congress.

■ **The Committee recommends that Congress use a Science and Technology Study Conference or related legislative service organization to aid in the coordination of requests for certain support agency analyses, including parallel or joint analyses by two or more agencies.**

A strength of the present support agency system is the diversity of sources of analysis and advice. Each agency examines a question from a different perspective and with a different mix of expertise. On occasion, in order to take advantage of this diversity, legislators will request reports from more than one agency but, customarily, a study is made by a single agency.

The Committee recommends that in order to allow more in-depth examination of certain issues, Congress more frequently consider requesting parallel studies of particular S&T problems. For example, if a committee is planning a series of hearings in connection with reauthorization of legislation two years in the future, the Committee should carefully consider the capabilities of the support agencies and request complementary studies that will benefit its deliberations. An OTA assessment in conjunction with a GAO program review and perhaps a CRS legislative analysis can provide a more complete analytical picture than any one of these products by itself. For example, in responding to an emerging environmental problem, OTA could undertake an assessment of the scientific nature of the problem, GAO could evaluate the strengths and weaknesses of the regulatory and research efforts of the relevant federal agencies, and CRS could evaluate potential ways of addressing the issue through amendment of pertinent federal statutes. To some extent these arrangements have been made in the past. The Committee believes that more frequent parallel and joint studies and other types of cooperative effort would serve Congress well.

When Congress requests multiple, parallel studies, it should encourage the support agencies to communicate regularly throughout the process to avoid unnecessary duplication of effort and to ensure that all aspects of an issue are being addressed. On occasion, congressional committees may wish to go beyond parallel studies to joint studies. Such studies might be appropriate when what is needed is a single, comprehensive report that presents an in-depth analysis of an issue and a coherent approach to address it.

The support agencies have formal and informal mechanisms in place to coordinate their efforts. The OTA Congressional Board, for example, also functions to screen study proposals, and it may suggest interagency interactions. These mechanisms work well at times, but the Committee believes that coordination efforts can be substantially improved.

Congress should consider using a Science and Technology Study Conference or similar legislative service organization to provide assistance in coordinating some requests of this kind. The concept and potential activities of an S&T Study Conference were discussed in the first Committee report, *Science, Technology, and Congress: Expert Advice and the Decision-Making Process.* The Study Conference could, for example, periodically convene meetings between committee staff and representatives of the support agencies to discuss future studies, including joint and parallel studies by multiple agencies.

■ **The Committee recommends that Congress request analytical assistance from the support agencies, particularly the Office of Technology Assessment, to aid congressional decision making with respect to establishing S&T goals and budget priorities.**

Priority setting involves the integration of political and economic concerns, and, as noted earlier, there are no precise road maps or methodologies to guide the policy maker in this regard. However, legislators can benefit greatly from analyses that assess the likely consequences of alternative choices from both the technical and the economic perspectives. The support agencies can assist Congress by undertaking analyses that will help Senators and Representatives set priorities for scientific and technological projects, programs, and facilities. The Committee recommends that Congress encourage the support agencies, particularly the Office of Technology Assessment, to develop the capability to assist Congress in this important area. For example, there is a need to develop better methods and indicators of R&D "outputs" as well as the economic implications of different R&D programs.[34] To this end, the Committee encourages committee and personal staff to work with support agency staff and outside experts to evaluate congressional information needs and ways to meet them. The Committee will address the priority-setting issue in more detail in its third report.

If Congress wishes the support agencies to do more work in establishing long-range goals and budget priorities, more funds will be necessary for staff and program-related expenses.

■ **The Committee recommends that Congress preserve and expand the opportunity for support agencies to self-initiate certain studies, particularly those designed to anticipate future S&T-related challenges or activities that Congress may wish to develop or support.**

Anticipating future events or research needs is in part an art, and few individuals can claim notable successes. Yet certain trends can be projected into the future, allowing reasonable predictions of S&T-related chal-

lenges for the years ahead. The support agencies can assist Congress in monitoring S&T developments worldwide and in identifying problems in need of attention. As an organization often criticized for reacting primarily to immediate concerns and pressures, Congress should continue to encourage anticipatory studies that can help identify emerging issues requiring legislative action or oversight activities. Such studies are also useful in developing preliminary information that may result in a committee request for a full-scale assessment.

The Committee believes it is important to encourage the support agencies, particularly OTA and CRS, to continue to initiate anticipatory studies periodically. The agencies should be encouraged to look ahead, to try to identify the legislative and oversight issues of the future, and to suggest ways that Congress can begin to tackle issues before they are brought to the steps of the Capitol as problems that demand immediate attention. OTA's Technology Assessment Advisory Council could play a more active role in identifying potential anticipatory studies and could make recommendations to OTA for initiating such studies. The Committee recommends that Congress provide the support agencies with additional funds for studies of this kind.

At present, OTA's congressional board has limited "planning" and "special response" (Director-approved) studies to no more than 20 percent of the budget. The board may wish to consider establishing a lower limit as well—perhaps 10 percent—to encourage the production of anticipatory studies.

The analytical divisions of the Congressional Research Service have occasionally undertaken anticipatory studies. The Committee believes Congress should continue to provide CRS with the resources and authority to undertake studies of this kind. At times, cooperative OTA and CRS efforts might be appropriate and worthwhile.

■ **The Committee recommends that Congress review the collective S&T capabilities, budgets, and accomplishments of the four support agencies every four to six years.**

The support agencies do not now benefit from regular, comprehensive reviews of their collective science- and technology-related budgets, programs, and personnel. Oversight of each agency's activities, which occurs during the authorization and appropriations process, is limited; individual agency reviews, moreover, do not allow a broad evaluation of the capabilities of the four organizations as a whole. Given the rapid changes in the S&T area, such a periodic review would benefit both Congress and the support agencies by identifying agency strengths and weaknesses, and suggesting modifications in activities to meet the changing needs of legislators and

their staff. Such an analysis could be undertaken under the auspices of a Science and Technology Study Conference, jointly by the Senate Committee on Commerce, Science, and Transportation and the House Committee on Science, Space, and Technology, or, at the request of Congress, by an outside organization.

GENERAL RECOMMENDATIONS TO ALL THE SUPPORT AGENCIES

■ **The Committee recommends that the support agencies explore approaches to more effective delivery of information to Congress and the public.**

Technological developments have led to rapid advances in communications technologies. New mechanisms for delivering information to Congress and the public are constantly evolving, and the support agencies should continue to explore approaches to enhancing information transfer. Making more information available on-line, developing indexing systems that will allow easy access to data, and improving the presentation of information in reports are examples of some of the improvements that can be made.

Congressional staff indicate that informal approaches to communicating information are particularly helpful and that regular updates on developments of specific interest to individual Members and committees are especially useful. All of the agencies could improve report follow-up activities, targeting information to Members and staff with special interests and responsibilities.

Each support agency has different policies and approaches to making reports available to the public. GAO has an advanced and efficient system for cataloging reports, notifying the public of recently released reports through its monthly publication *Reports and Testimony*, taking telephone and written requests for publications (up to five copies of which are provided free of charge), and filling orders on a rapid-turnaround basis through its centralized distribution system.

CRS prepares many reports of interest to individuals outside Congress, but because of congressionally mandated restrictions, few are made available to the public. The Committee encourages CRS to seek authority from appropriate congressional committees to allow greater public access to selected CRS documents, including issue briefs and special policy analyses.

Later in this report, the Committee recommends that the Library of Congress appoint an expert panel to provide advice and to develop a long-term plan on ways of making S&T information readily accessible, by means of advanced information technologies, to users both within and outside Congress.

Another useful approach to the dissemination of congressional documents is to encourage private publishers to reprint popular support agency documents. Because congressional reports are public documents, they are not copyrighted and may be published privately. Some OTA reports have received wide distribution in this way. The Committee believes that arrangements of this kind should be encouraged, perhaps by fostering closer links and informal agreements with interested publishers.

The Committee believes that efforts by the support agencies to convey information to the public more effectively would enhance public understanding of important science and technology policy issues and indirectly improve Congress's ability to make informed decisions about them.

■ **The Committee recommends that the support agencies improve their capabilities to analyze international issues with substantial scientific and technological content.**

As discussed earlier, the globalization of economic, political, environmental, and social concerns has led to a world in which the actions of one nation often have direct consequences for another. Clearly, one nation acting alone cannot solve the major scientific and technological challenges facing industrialized and developing countries. Therefore, the United States must continue to work with other nations in advancing S&T enterprises worldwide.

The Committee recommends that the support agencies enhance their capability to address international S&T issues and the S&T aspects of broader issues. The support agencies should also improve their ability to alert Congress to ways in which U.S. S&T-related accomplishments could be used to benefit the world community, particularly developing nations.

■ **The Committee recommends that the support agencies enhance efforts to communicate and cooperate with one another in the analysis of S&T issues.**

Although the support agencies can point to examples of effective coordination, the Committee believes that such efforts can be substantially improved. Each agency has a different analytical niche, and the capability to evaluate a problem from different perspectives is a strength of the support agency network that should be exploited more frequently.

Parallel and joint studies are one way to achieve this result. In addition, temporary personnel exchanges can be beneficial to both agencies and employees and should be utilized more frequently. Communication between and among agencies should be enhanced, not just at the senior levels but at the level of the analyst with day-to-day responsibilities for a subject area. Regular informal meetings between support agency managers and staff have proven to be a useful way to develop communication channels. More frequent meetings of this kind would be beneficial.

FINDINGS AND RECOMMENDATIONS SPECIFIC TO EACH SUPPORT AGENCY

THE OFFICE OF TECHNOLOGY ASSESSMENT

The Committee finds that the full-scale assessment is the preeminent OTA activity and that it results in a product that is widely used and appreciated by Congress, the scientific community, the public, and individuals and organizations in other nations.

Individuals both inside and outside Congress recognize the importance and usefulness of the full-scale OTA assessments.* Congressional staff value these studies for their comprehensiveness and because, through advisory panels, they take into account the views of experts throughout the country.[26]

The Committee finds that OTA reports are of high technical quality. Nonetheless, the excessive length of many reports weakens their impact, while the length of the assessment process sometimes results in the delivery of reports after congressional interest has peaked or after policy responses have been developed. In addition, the "Issues and Options" section† (the chapter of OTA reports devoted to potential policy responses) often does not give sufficient attention to alternative responses to the problems discussed in the main body of the report.

In an effort to be comprehensive and to address all of the technical aspects of an issue, OTA reports are frequently more than 300 pages long. Although such documents are useful as reference sources, they are rarely read by Members. (For this reason, and to communicate key ideas to Members, OTA prepares summaries of its reports.) The Committee believes OTA should strive to make the technical discussion within OTA reports more concise, focusing attention on key principles and facts while avoiding details of only marginal use to legislators and their staff.

Congressional staff feel that the policy issues and options sections of OTA assessments often do not provide enough detail, making it difficult for staff to translate broad policy suggestions into practical legislative initiatives. To address this deficiency, the Committee suggests that OTA place greater emphasis on the analysis of policy issues and options and begin drafting this section earlier in the assessment process. The Committee also recommends that the agency consider appointing more individuals with public

* A full-scale OTA assessment is a complete OTA analysis and report, guided by a panel of experts from outside the government. A study of this kind typically takes 18 to 24 months to complete.
† The "Issues and Options" chapter of an OTA report briefly describes key policy issues, alternative means to address them, and the consequences of pursuing a particular alternative. OTA does not make specific policy recommendations.

policy experience to its advisory panels. In addition, OTA should expand its follow-on activities to develop further the ideas outlined in the issues and options section of its reports.

The Committee finds that the present ceiling of funds and permanent positions at OTA does not allow for needed expansion of staff capabilities in important analytical areas.

One of OTA's strengths as a federal agency is its small size—only 143 permanent positions. However, despite substantial increases in workload and modest funding increases (Table 3), OTA has been operating at this staffing level since 1987. The Committee believes that, in addition to management improvements, an increase of 12 to 15 positions (about 10 percent above current levels) over the next 5 years would allow OTA more flexibility in dealing with its increasing responsibilities. For example, such an increase would enable the agency to undertake, as recommended in this report, additional work in the international area, develop analytical skills in support of priority setting, and experiment with new communications approaches.

Table 3. OTA Information Products and Resources, FY 1982–1991[a]

	1982	1984	1986	1988	1990	1991
Total budget ($1,000)	12,140	14,802	14,597	16,851	18,571	19,557
Total budget (constant 1982 $1,000)	12,140	13,744	12,816	13,892	14,122	14,220
Full-time positions	129	139	136	143	143	143
Reports published	18	17	18	31	28	26
Other documents published	18	18	25	10	15	11
Testimony delivered	51	42	28	55	49	47

[a] From Rodney W. Nichols[35] and OTA.

■ **The Committee recommends that OTA preserve and enhance its capabilities for undertaking in-depth, nonpartisan assessments of critical S&T issues, including those pertaining to "policy for science."**

The Committee recommends that OTA preserve its primary mission: to undertake full-scale assessments of important scientific and technological issues. OTA has built a solid reputation for its assessment activities and should continue to make them its highest priority.[35]

The Committee recommends that OTA significantly expand and sharpen the "Issues and Options" sections of its reports, including more extensive discussion and analysis of policy and legislative options. The Committee does not believe OTA should develop recommendations but feels that a more extensive discussion of issues and options would satisfy the needs of Members and staff for additional practical information on how to address a problem. The Committee believes there should be regular consultation between OTA staff and Advisory Panel members throughout the development of a report.

The Committee also encourages OTA to continue to avoid initiating more studies than its resources allow. The temptation to respond to all requests or to pursue the interests of agency staff can strain resources to the point that report quality suffers. The Committee believes that, given a choice between quality and quantity, OTA should choose the former, devoting optimal resources to a smaller number of high-priority studies.

The Committee identified opportunities to improve assessment activities. In particular, OTA should strengthen its capacity to address issues pertaining to "policy for science," including questions on S&T budgets and priorities, personnel, facilities, and educational policies. OTA's recent report *Federally Funded Research: Decisions for a Decade*[36] is an example of a recent agency contribution in this area. OTA may wish to modify its organizational structure to enhance its capability to address "policy for science" issues.

The Committee also believes the process by which OTA assessments are undertaken could be improved in several areas. Members and their staff frequently need information in OTA reports before they are completed, and many staff feel that OTA reports take too long to produce. OTA is currently addressing the need to generate information more quickly by producing brief interim documents specifically addressing the requirements of a committee. OTA is also making more frequent use of advance staff briefings to convey early findings to requesting committees.

To provide Congress information in a more timely manner, the Committee encourages OTA to develop a "short cycle" mechanism to undertake special studies in a 10- to 12-month period rather than the typical 18- to 24-month (sometimes longer) cycle required to prepare a complete assessment. This step would be feasible if a study were less comprehensive and

focused on specific issues of interest to the requesting committee, if a smaller advisory panel that met more often than a full panel were established, and if the Technology Advisory Board agreed to approve the initiation of such studies and to review the resulting reports on a quick-turnaround basis. Another approach to the preparation of special studies on a short cycle might involve cooperative efforts by OTA and CRS in which the two agencies work together to develop such reports.

■ **The Committee recommends that OTA continue to take full responsibility for its reports; however, OTA should inform legislators and the public of the range of opinions it has considered through its advisory and review processes.**

Although OTA obtains opinions on its draft reports through advisory panels, workshops, and merit review, the agency takes full responsibility for its reports. The Committee believes that OTA should continue this policy. Unlike studies sponsored by the National Academy of Sciences, OTA assessments are written by staff with guidance from an advisory panel of experts representing a broad range of perspectives. OTA studies take into account the diverse opinions of advisory panel members and others; however, the reports are not consensus documents. Consequently, the responsibilities of authorship lie with OTA and not with the advisory panel. Over the years, this approach to preparing documents has proven to be both efficient and highly effective.

However, either on a routine basis, or for certain controversial studies, the Committee recommends that OTA include in the appendix of a report a brief description of the range of comments received during the review process and highlight differences of opinion on sensitive issues. According to OTA's current director, "If the OTA report does not reasonably communicate the range of thinking about the issue, then the report should be faulted."[13] In some cases it would be helpful if OTA included an explicit discussion of how dissenting or alternative views are accounted for in the published report. Such a discussion would give readers a better sense of the range of opinions on controversial issues. The Committee believes this information would benefit legislators, who must routinely take into account a range of opinions when formulating policy.

■ **The Committee recommends that OTA develop the analytical capability to assist Congress in the S&T priority-setting process, and that the agency develop procedures to assist Senators and Representatives in making such decisions.**

Severe budget constraints are likely to continue as requests for support of a range of new and existing S&T programs and projects increase. Setting priorities under these circumstances is one of the most significant

emerging concerns of legislators and their staff. Although legislators have called on the scientific community for assistance in prioritizing funding requests, there are inherent conceptual difficulties in weighing the relative merits of projects, particularly across scientific disciplines. Congress itself is uncertain about how to approach the problem of establishing priorities.

OTA should not become involved in the political judgments associated with priority decisions themselves but could play an important role in evaluating alternative priority-setting scenarios. OTA could also assist Congress with priority-setting questions by expanding its current efforts to compile data (for example, indicators and indices) and could develop criteria and decision-making procedures to reveal choices more clearly and thus help guide legislators in making decisions on budget priorities.

■ The Committee recommends that OTA enhance its capabilities for economic analysis and integrate economic analyses more frequently in its assessment activities.

In recent years, economic analyses have become increasingly important components of technology assessments. Congressional interest in enhancing the U.S. competitive position has strongly influenced many of OTA's activities in this area. In 1988, OTA published a study that for the first time took a broad look at the economic impact of emerging technologies on American society.[37] Eight congressional committees asked the agency to suggest ways to improve U.S. economic policy in the context of science, technology, and the emerging global economy. Questions of this kind are likely to continue to dominate the congressional agenda, and OTA should take steps to assure that its programs have the expertise to address economic issues as they pertain to science and technology.

It is useful to distinguish budget analysis from economic analysis. In general, the Committee views *S&T-related* economic analysis to be the primary activity of OTA as it assesses policy issues, and its sees budget analysis as the responsibility of CBO as it evaluates program costs and revenue issues. In addressing the economic policy aspects of its assessments, OTA should periodically consult and/or work cooperatively with CBO. CBO, in turn, should, when examining the S&T aspects of economic policies and budgets, solicit the cooperation and assistance of OTA.

■ The Committee recommends that OTA expand assessment capabilities in the international arena.

In the years ahead, science and technology policy questions will have increasingly important international dimensions. OTA assessments have included international issues in the past; however, as demonstrated by world

events in the last several years, it is likely that this component of S&T policy issues will grow substantially.

As the focal point for technical analyses of these issues, OTA program offices should, as part of their assessment activities, expand their consideration of international questions.[36] This effort may include, for example, increased overseas research by staff and more frequent participation of individuals from other nations in OTA activities. In certain international activities, OTA should work with the other support agencies in developing and analyzing information. The GAO field offices, for example, offer a mechanism for facilitating evaluations in foreign countries and for tapping directly the technical information resources of other nations.

■ **The Committee recommends that OTA take steps to assure attraction and retention of outstanding personnel, and take advantage of opportunities to use experts from federal and state agencies on temporary assignments.**

Over the years, OTA has employed a number of people who have gone on to become leaders in the science and technology policy arena. Indeed, the agency is gaining recognition as an important training ground for policy analysts. OTA has worked to strike a balance between the turnover it requires to bring new talent into the agency (in the words of one OTA official, the agency strives to be "lean and mean") and the stability it must have to assure a reservoir of experienced staff. The Committee recognizes the challenge OTA faces in striking this balance. Clearly, the agency has emerged as a widely respected analytical organization, and it should continue its efforts to attract and retain highly qualified and experienced policy analysts and program managers.

OTA should seek approval of the Technology Assessment Board and appropriate congressional committees to establish a formal sabbatical program. Such a program would give selected individuals who have worked in the agency for a number of years an opportunity to spend 6 to 12 months in academia, nongovernmental organizations, or elsewhere learning new skills to assist them in their future work. The Committee believes the program should be highly selective, providing sabbatical opportunities only to outstanding individuals who plan to continue to work in the agency.

In addition, OTA should continue, strengthen, and expand its Congressional Science and Engineering Fellows program, recently renamed the Morris K. Udall Fellows program, as a mechanism for bringing new talent into the Agency. Each year three or four individuals are selected from a pool of some 120 applicants, usually recent graduates of advanced degree programs, to serve for a year as Fellows in the various program offices. Of the 60 Fellows selected between 1978 and 1990, seven currently hold permanent and three hold temporary positions in the agency.[33] Most join the agency

for one to three years and participate in one or more assessments in their area of expertise. The program has proved to be highly successful, and consideration should be given to selecting more candidates for fellowships. Perhaps OTA could occasionally appoint Fellows from other countries to come to the United States for 6 to 18 months to work and learn-by-doing at OTA.[13] These Fellows could return home to undertake similar activities in their own countries. In addition, OTA may wish to develop employment incentives to encourage a larger number of Fellows to remain with the agency for longer periods of time.

OTA periodically augments its analytical staff through temporary assignments of individuals from federal agencies who have specialized expertise. OTA could also tap the capabilities of experts in state agencies and elsewhere through temporary assignments made possible by the Intergovernmental Personnel Act.

■ **The Committee recommends that OTA seek approval of the Technology Assessment Board to undertake more discretionary studies, particularly those designed to anticipate future S&T challenges.**

The OTA Director currently has the authority to initiate studies without OTA Technology Advisory Board approval if the total cost will not exceed $50,000. Discretionary studies add an important dimension to OTA's capabilities because they allow the director flexibility in responding to both internal and external suggestions for small, often rapid-turnaround studies of critical issues. Given the cost of undertaking such analyses, the Committee believes it would be desirable for Congress to raise the ceiling for director approval of discretionary studies to $75,000 and to provide additional funds for such studies. The Committee recommends that the director periodically seek the advice of the Technology Assessment Advisory Council regarding potential anticipatory studies.

■ **The Committee recommends that OTA explore ways to enhance its interactions with other outside organizations, including the White House Office of Science and Technology Policy, state analytical organizations, and academic and nongovernmental organizations, particularly those with programs devoted to technology assessment and science and technology policy.**

It is imperative that OTA preserve its independence as a nonpartisan analytical organization working to support Congress; however, the agency could explore new approaches to cooperating with other policy analysis organizations.[35] For example, OTA could experiment with new ways to interact

with the White House Office of Science and Technology Policy, provided that exchanges of information are reciprocated.

Outside organizations, including policy think tanks, academic institutions, and analytical units in the executive and legislative branches of state governments, are more often undertaking science and technology assessments and policy studies of various kinds. OTA, as the national leader in technology assessment activities, could orchestrate both formal and informal cooperative efforts to advance the processes by which policy studies in general, and technology assessments in particular, are carried out. More field work, for example, and greater interaction with state institutions would strengthen certain studies.

■ **The Committee recommends that OTA explore new approaches for delivering information to both Congress and the public, and expand the distribution of its reports, especially to state governments.**

Communications technologies are evolving rapidly, and OTA should continue to explore more efficient means of transferring information to Congress, the scientific community, and the public. Possible new approaches include on-line availability of OTA report summaries and perhaps full reports and use of CD-ROM technology to store reports and contractor papers.

OTA should also take advantage of personal contacts in communicating information to Members and staff. Congressional staff report that they find such contacts to be as useful or more useful than written agency products.[26] OTA should experiment with different forms of staff briefings to allow managers and project directors to discuss report findings, issues, and options for action with legislators and their staff. OTA may also wish to explore mechanisms for encouraging communication between advisory panel members and congressional staff who may wish to discuss certain aspects of final reports in more detail.

Although OTA reports have a national focus, many issues that the agency evaluates are of direct interest to state governments. Whether the subject is technology and competitiveness, control of toxic substances, energy conservation, or health care for the elderly, the policy issues and approaches to tackling the problems are often similar at the national and state levels. Indeed, many policy responses require actions by, and cooperative efforts between, both federal and state governments. OTA reports are regularly provided to governors and often to selected state agencies. The Committee believes OTA should make a more concerted effort to identify "receptor sites" for its reports in the states, including key state officials and legislators. and legislators.

THE LIBRARY OF CONGRESS AND THE CONGRESSIONAL RESEARCH SERVICE

The Committee finds that the Congressional Research Service and the Library of Congress in general are highly regarded by legislators and their staff as reliable sources of timely scientific and technical information and analyses of various kinds relevant to the immediate needs of Congress. The Library of Congress, in particular, has recently undertaken promising S&T-related initiatives, both domestic and international in orientation, that are likely to benefit both Congress and the nation.

The Committee finds that the Congressional Research Service faces shortages of scientific and technical personnel, particularly at the senior levels, at a time when the demand for S&T-related services is steadily increasing. Both resource limitations and rigid personnel policies appear to be responsible for these shortages.

The Committee also finds that the Science Policy Research Division and the Environment and Natural Resources Policy Division of the Congressional Research Service have played a central role in the analysis of a broad range of science and technology policy issues for Congress. The divisions have proven particularly adept in producing rapid-response analyses, a category of information product in high congressional demand.

■ **The Committee recommends that the Library of Congress and the Congressional Research Service act to assure that, in the effort to maintain and strengthen capabilities for quick-response reference services, S&T analytical capabilities are not weakened.**

Between 1980 and 1990 science- and technology-related information requests increased by 36 percent while the number of staff positions declined by 17 percent[38] (Table 4). The pressure to respond to this volume of requests, given significant personnel limitations, has resulted in management decisions to place a high priority on hiring junior staff to support reference programs. The result has been a slowdown in filling midlevel and senior positions in the analytical programs. Although current CRS policy is to respond to all reasonable information requests, without additional congressional funding, the agency may have to decline or limit its response to requests and refer some individuals to other information sources.

The S&T-related information needs of Congress have grown steadily over the last decade, and substantial budget limitations have limited CRS's capability to expand its production level to meet these needs in all areas. CRS has had more frequently to prioritize its work and to divert resources to critical areas. This development has led to less than optimal coverage of important but less crucial areas of work, including postponing the prep-

Table 4. CRS: S&T-Related Information Products and Resources, 1980–1990

Year	Analytical Reports	Inquiries Cleared	Staff (full-time equivalents)	Total Costs ($1,000)	Total Costs (constant 1982 $1,000)
1980	61	9,956	101.5	3,489	4,038
1985	183	9,932	86.0	4,777	4,415
1990	92	13,507	84.5	5,653	4,325
% change 1980–1990	+50.8	+35.7	−16.7	+62.0	+7.1

aration of certain information products. CRS believes it can improve and expand its analytical services to Congress, but it is unable to do so because of resource limitations.[20]

The Science Policy Research Division, in particular, is looked to for detailed analyses of a wide range of science and technology policy issues requiring the expertise of senior staff who understand the politics and the legislative procedures. The Committee urges CRS to preserve its analytical capabilities and to avoid management policies that slow the filling of mid- and senior-level positions in the Science Policy Research Division and the Environment and Natural Resources Policy Division.

■ **The Committee recommends that, in order to analyze and comment on legislative approaches to issues raised in Academy studies, CRS develop a closer working relationship with the National Academy of Sciences complex.**

The National Academy complex—which consists of the National Research Council, the National Academy of Sciences, the Institute of Medicine, and the National Academy of Engineering—generates 200 to 250 reports annually on a wide variety of issues. Legislators and their staff view the Academy complex as a highly credible source of information on S&T issues and they value Academy reports as statements of the consensus of the nation's best minds on critical scientific questions. However, congressional staff often have difficulty developing practical policy solutions to the questions raised in Academy reports. Because Academy studies customarily describe problems and offer general recommendations for action but do not prescribe specific legislative language, important Academy studies are often not implemented.

CRS could facilitate congressional action on certain Academy studies

by acting as a bridge between the Academy complex and Congress. For example, CRS could develop, at the request of congressional committees, assessments of legislative approaches to implementing action recommended in particular Academy reports.

■ **The Committee recommends that the Library of Congress appoint an expert panel to provide advice and to develop a long-term plan on ways of making S&T information readily accessible by means of advanced information technologies, to users both within and outside Congress.**

Congress and its support agencies generate a wealth of information that should be more accessible to the public. Documents such as hearing reports include expert testimony on many important public policy issues, but locating and obtaining copies of these documents is often difficult. The Committee encourages the Library of Congress to develop an advanced information and storage retrieval system to facilitate public access to documents generated by congressional committees and support agencies.

For some time, the Congressional Research Service has used computer technologies to provide information to Congress. The SCORPIO software system provides on-line access to CRS "issue briefs"* and citations of public policy literature, including congressional documents and support agency reports. CRS also recently began using new optical disk storage and retrieval systems. In addition, a special task force, under the direction of the Architect of the Capitol, is developing a telecommunications system that will link congressional offices, committees, and the support agencies.[20]

The Library of Congress should continue to pursue emerging technologies that facilitate access to Library collections. CD-ROM, videodisc, and advanced computer systems offer significant opportunities for enhancing storage of and access to scientific and technical information. The Committee encourages the Library to appoint a panel of experts to provide advice and develop a long-term plan on ways to make optimal use of advanced information technologies.

The Library of Congress has initiated a program to make information of historical significance accessible to libraries throughout the United States. The American Memory program reproduces photographs, recorded sound, motion pictures, and publications on compact and videodiscs. Individuals will eventually be able to visit public libraries and schools to obtain access to the American Memory collections, using advanced cataloging systems to search for information and electronically copy data for further study.[39] Consideration should be given to the development of a similar system to store congressional documents electronically and make them avail-

* Issue briefs are short documents describing key public policy issues of interest to legislators.

able from terminals in libraries and schools, and eventually from computers in homes and business.

■ **The Committee recommends that the Library of Congress expand its efforts to link Library collections with those of other nations and to provide American citizens with access to referral information on the availability of scientific and technical information developed in foreign countries.**

The Library of Congress is currently establishing an Automated Reference Center (ARC) that will contain computerized information about sources of technical information throughout the world. The center will eventually allow access to information on experts, data sources, and gray literature (technical reports and conference papers) in foreign countries. Initially the system will cover gray literature of North America and Japan, but ultimately the Library hopes to expand the scope of the Center to include scientific and technical literature, and other information sources worldwide.[40] The Committee endorses these efforts and encourages Congress to provide the Library the resources necessary to develop and operate the ARC.

THE GENERAL ACCOUNTING OFFICE

The Committee finds that GAO plays an important role as the chief investigative arm of Congress, auditing and evaluating government programs and management, including activities related to science and technology. GAO has unique analytical capabilities, particularly for examining the international components of S&T issues through GAO field offices abroad as well as in the United States.

The Committee finds that scientific and technical staff at GAO is very limited in relation to the mission and size of the organization and the requirements for a balance of expert knowledge in a variety of disciplines. Such limitations in staff expertise are responsible in part for the inconsistent quality of GAO studies.

Unlike the OTA and CRS, GAO makes recommendations in its reports prepared in response to specific requests from Congress, including those from individual Members. This approach places a premium on maintaining objectivity and political impartiality in GAO studies.

■ **The Committee recommends that GAO establish an Office of Science and Technology with a director responsible for providing advice and assistance to the Comptroller General and other senior officials concerning S&T-related studies carried out by the agency.**

A small Office of Science and Technology could function like the

existing GAO Office of the Chief Economist, providing an array of services in support of the Comptrollers General and the agency as a whole.[24] The office would serve as the science advisor to the Comptroller General, providing him and the Assistant Comptroller General and their senior staff with expert advice on scientific and technical questions. An Office of Science and Technology could convene panels of outside experts to assist in the technical aspects of certain GAO studies or to serve as reviewers of draft reports. The office could also be assigned broad quality-control responsibilities with respect to scientific and technical studies.

The Office of Science and Technology could undertake broad science and technology policy studies that cut across the GAO divisions and could play a coordinating role within the agency by helping to bring different parts of the organization together to work on certain types of scientific and technical analyses. The office could serve as the liaison for interactions with the other support agencies and could assist congressional staff in developing requests for S&T-related GAO studies.

■ **The Committee recommends that, to assure adequate analytical capabilities in S&T areas, GAO strengthen its technical expertise.**

GAO has developed a clear analytical niche with respect to congressional needs and the missions of the other support agencies. GAO has the authority to examine nearly all federal programs and activities and to review or audit the actions of federal employees, contractors, grantees, or any others who benefit from government funds, laws, and regulations.[24] GAO's strength is in evaluating such questions as these: Are government programs being carried out in compliance with the law? Are data furnished to Congress on these programs accurate? Are there opportunities to eliminate waste and inefficient use of public funds? Are federal programs being operated effectively, and if not, how can they be better managed?[24]

The Committee believes that GAO's analytical capacity in the science and technology policy area should be strengthened to meet the needs of Congress in the next decade and beyond. GAO's special ability to evaluate questions related to program effectiveness and financial management are particularly important, and its capability to evaluate issues through its field offices throughout the United States and in foreign countries is unique among the congressional support agencies. The Committee believes that the technical quality of GAO reports could be substantially improved if the agency employed more scientists and engineers in its various program areas. Of the several thousand GAO employees, only about 200 hold PhDs, and of these, only 12 individuals (0.3 percent of the total number of employees) have degrees in mathematics, engineering, and the biological sciences, while no GAO employee holds a PhD in the physical sciences.[41] GAO is sensitive

to the personnel issue and is working to employ more individuals with scientific and technical expertise. One way to attract talented individuals to the agency is through a Congressional Fellows program. The Committee suggests that GAO consider establishing or participating in a Congressional Fellows program similar to the program sponsored by OTA.

THE CONGRESSIONAL BUDGET OFFICE

The Committee finds that, consistent with its mission, CBO has limited responsibilities with respect to science and technology policy, and CBO's recent work in the S&T area has been confined to periodic analyses of spending and revenue issues associated with selected S&T programs and initiatives. CBO has made important contributions to congressional debate of several key S&T issues.

The Committee finds that at present CBO has committed the equivalent of approximately two full-time staff positions to the analysis of S&T-related budget matters. These positions are located in the agency's Natural Resources and Commerce Division.

■ **The Committee recommends that CBO enhance its capabilities for analysis of the budgetary considerations of S&T programs and proposed initiatives.**

CBO's mission is to support the congressional budget process by evaluating spending and revenue issues associated with the entire federal budget. CBO's well-defined, but large and complex, mandate places formidable demands on this small support agency. CBO provides a variety of products and services to Congress ranging from telephone consultations and staff briefings to cost estimates for each bill reported to Congress, an annual compilation of deficit reduction options, technical memoranda, and in-depth policy studies.[42] Science and technology pervade the federal budget; consequently, in the course of responding to congressional budget-related mandates and related information requests, CBO analyses implicitly examine matters related to R&D expenditures. However, very few of CBO's analyses focus primarily on S&T issues.

Recent CBO studies related to scientific and technical concerns include reports on using federal R&D to promote commercial innovation,[43] using R&D consortia for commercial innovation,[44] and encouraging private investment in space activities.[45] In addition, the agency has undertaken analyses of the proposed superconducting super collider (SSC),[46] the National Aeronautics and Space Administration's program plan for the 1990s and beyond,[47] and the budget history of large nondefense science and technology

projects.[48] The SSC and R&D consortia (including Sematech) reports were somewhat controversial, in part because they raised questions about popular assumptions regarding the financial underpinnings and ultimate costs of these major technological enterprises. Analyses of this kind are important to the evaluation and debate of S&T issues in Congress.

The Committee anticipates that present trends toward more congressional attention to S&T-related budget issues will continue and that the combination of more proposals, more expensive programs, and continued budget constraints will result in a greater demand for CBO analyses in this area. To ensure that CBO is capable of meeting this demand, the Committee recommends that the agency consider expanding its S&T-related analytical capabilities. If new positions become available, some of the new staff should have, in addition to economic and analytical skills, scientific and technical backgrounds.

To ensure the technical quality of CBO's S&T-related reports, the Committee recommends that CBO enhance its report review process by making greater use of experts outside the federal government. The Committee also suggests that the Director of CBO formally invite the Director of OTA to comment on draft reports that involve scientific and technical issues.

■ **The Committee recommends that CBO work with congressional committees, the Office of Technology Assessment, the Congressional Research Service, the Office of Management and Budget, and the Office of Science and Technology Policy within the Executive Office of the President to consider ways of improving the presentation and analysis of S&T-related budget information.**

The Committee believes that the quality of budget data provided by the executive branch on S&T-related federal programs can and should be substantially improved and that CBO, from the congressional perspective, should suggest ways of doing so. As Congress and the executive work to make policy decisions on S&T-related budget priorities, the presentation of such data in a format that is comprehensible and consistent across federal agencies is essential. Enhanced cross-cutting analyses, in particular, are necessary to aid in the examination of major program areas that involve efforts in multiple federal agencies. In the last two years, the executive branch has improved its presentation of budget information in several areas, most notably on global climate change research, and these improvements have benefited both executive branch officials and legislators in evaluating existing programs and developing new initiatives. Yet improvements remain to be made in developing comparable information on federal R&D budgets and in other areas.[49]

More extensive cross-cutting budget analyses based upon data that

are consistent across federal agencies would be especially helpful to Congress and to others outside government in examining complex S&T programs that involve research efforts in multiple federal agencies. The improved presentation of budget information would prove particularly useful to legislators in making decisions about S&T program priorities and trade-offs.

The Committee on Science, Technology, and Congress plans to examine more specific improvements in the presentation of budget information as part of its upcoming work on the budget and appropriations process. These issues will be discussed further in the Committee's third report.

4
CHALLENGES FOR THE FUTURE

As the nation moves into the 21st century, the American people and the elected officials who represent them will look increasingly to science and technology to help meet societal challenges. In making S&T-related policy decisions, Senators and Representatives need information, analysis, and advice from a wide range of sources both within and outside Congress. So long as the support agencies maintain the trust of Congress through the quality and balance of their work, they will continue to be looked upon as essential sources of information and analysis.

In recent years, the support agencies have built a solid record of achievement, even as demand for information has risen and resources have remained steady or have modestly increased. The Committee urges Congress to monitor closely the resource needs of the support agencies and to ensure that they have sufficient funds to attract and retain outstanding personnel, to operate effectively, and to meet the needs of Members and staff. If the demand for information continues to rise and there are not concomi-

tant increases in funding, budget constraints may force the agencies to make difficult operational decisions. If this situation develops, the Committee believes support agency managers should resist pressures both to expand services and to cut corners to reduce costs. It is better to operate within a limited, well-defined mission with highly qualified and productive staff than to attempt to meet all congressional information needs.

As political issues evolve, the concerns and aspirations of legislators change. Although the support agencies must be alert to new opportunities and be ready to adapt their activities to changing demands, they must continue to offer the services they are best suited to provide. Making such adjustments correctly requires vigilance on the part of agency managers and staff and regular critical assessments of the strengths and weaknesses of their activities.

Perhaps the greatest internal threat to the support agencies is the temptation to believe that their special training and knowledge place them in a position of knowing what course of action is "best" or "in the national interest." The congressional *support* agencies support Congress, the 535 elected officials who have been chosen by the American people to make the laws that govern the nation. The challenge to the agencies will, therefore, be to present useful ideas, options for action, and, sometimes, recommendations, but not to enter the domain of the elected Senators and Representatives by attempting to establish policy.

The support agencies are a reservoir of scientific and technical knowledge, but legislators themselves are a source of the diverse values, ideas, and goals that embody the aspirations of the American people. It is the task of the Senators and Representatives to meld science with the values and concerns of the electorate. As legislators debate the policies of the future, it is the responsibility of the support agencies to provide Congress advice that is balanced, that takes into account a broad range of perspectives, and that is of the highest quality.

The congressional support agencies operate in an exciting, often highly volatile, political environment in which values and ideas are translated into public policy. Because the men and women who serve Congress in these agencies can help generate the ideas that shape national policy, Congress must maintain the strength and vitality of the support agencies.

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