FACING TOWARD GOVERNMENTS

NONGOVERNMENTAL ORGANIZATIONS

AND SCIENTIFIC AND TECHNICAL ADVICE

JANUARY 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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FACING TOWARD GOVERNMENTS

The most widely recognized participants in the private sector are those involved directly in the economic functions of the society—business people, farmers, union members. But there is today a new awareness of the nonprofit segment of the private sector. Like the profit segment, its institutions are extravagantly pluralistic—hospitals, museums, religious groups, civic organizations, great universities, citizen groups, scientific laboratories, social service agencies and so on.

In its size and diversity the nonprofit world is uniquely American; it stems from a deeply ingrained American habit of forming voluntary associations whenever a purpose might be achieved through joint action.

The sector is a significant source of renewal. An idea that is controversial, unpopular or strange has little chance in either the commercial or the political marketplace. But in the nonprofit sector it may very well find the few followers necessary to nurse it to maturity. The sector comfortably harbors innovations, maverick movements, groups which feel that they must fight for their place in the sun, and critics and dissenters of both liberal and conservative persuasion. And it is from just such individuals and groups that one may expect emergence of the ideas that will dominate our society and our world a century hence. Generally speaking, great social changes begin with few supporters.

—John W. Gardner, *Self-Renewal: The Individual and the Innovative Society*, 1981


To all Persons to whom these Presents shall come

GREETING

The American Philosophical Society held at Philadelphia for promoting Useful Knowledge, desirous of advancing the Interests of the Society and of doing Honour to themselves, by conferring Marks of their Esteem upon Men of Eminence and Literature, and especially upon that great and illustrious Citizen and Patriot, HIS EXCELLENCY George Washington Esquire, General and Commander in Chief of the Armies of the United States of North America, have therefore unanimously elected Him, the said George Washington a Member of the said Society, thereby granting unto Him and requesting Him to accept the Rights of Fellowship, with all the Liberties, Priviledges and Honours thereunto belonging.

In Testimony whereof the said Society have caused the Seal of their Corporation to be annexed to this Diploma or Certificate, & attested also by the Names of the proper Officers, this twenty second Day of March, Anno Domini one thousand seven hundred and eighty

William Smith
John Ewing
William Bache
Owen Biddle
} Secretaries

Th. Bond
Dav. Rittenhouse
James Wilson
} Vice Presidts.

George Washington's certificate of membership in the American Philosophical Society, the nation's oldest scientific nongovernmental organization, founded by Benjamin Franklin in 1743. The "philosophy" of the Society's name is "natural philosophy," the eighteenth-century term for the study of nature and the physical universe. (From the collection of the Library of Congress.)

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FOREWORD

The subject of this report is a loosely defined population of nonprofit nongovernmental organizations (NGOs) that range from broad-spectrum general-purpose scientific and technical groups, such as the American Association for the Advancement of Science, to elite academies, such as the National Academy of Sciences and its affiliated National Research Council, from there to an extensive array of discipline-specific societies, such as the American Physical Society, through think tanks dedicated to government work, such as the RAND Corporation, and on to policy advocacy groups, such as the World Resources Institute.

The United States is probably unique in the profusion and significance of its NGOs. They form an important component of the independent sector, as it is sometimes called, and are active in all aspects of life in the United States, from education and environment to arms control. NGOs are a force in the formation and implementation of policies affected by and affecting science and technology (S&T), contributing in varied capacities

to advancing research and analysis, advising government, influencing public opinion, and intervening in administrative rulemaking and legislative outcomes. The rationale is clearly that NGOs provide a needed and far-reaching dimension in mediating the relationships of science and technology with the government and the private sector.

The subject of nongovernmental organizations in fact has been ubiquitous in the deliberations of the Commission's study groups. NGOs are major players in determining the agendas for environmental research and regulation. The Commission's studies of S&T and the Congress have repeatedly shown the importance of the relationship of NGOs to the Congress. Private voluntary organizations active in the Third World are a main mechanism for action in the areas studied by the Commission's task force examining science and technology in relation to development.

The work of the Task Force on Nongovernmental Organizations in Science and Technology demonstrates the general utility and efficacy of NGOs examined for affinity to the goal of advancing and interpreting the roles of science and technology in society. In this report, the Task Force suggests ways of enhancing their potential, including both procedural improvements, such as means to assure the high quality of studies, and substantive themes, such as better mathematics and science education. Perhaps the chief utility of the Task Force's work lies in what it says to the governing bodies of nongovernmental organizations themselves. The report suggests that there may be family resemblances among those NGOs with which government should speak most seriously on matters of science and technology. All levels and branches of government could benefit from a better understanding of the potentials and constraints of NGOs in S&T.

Given the caution characteristic of the United States in assigning functions to the government and the continuing question of trust in public institutions, it is likely that the NGO sector will grow further in importance in coming decades. Yet the sector is not without problems and challenges. NGOs exercise in diverse degrees and for diverse ends the full range of options available to the independent sector. This very freedom, and the pluralism of the sector, creates its own kinds of tensions, as well as both healthy and unhealthy competition for public attention and funds.

In the end, we are impressed with how much NGOs count in our society in providing initiatives and making operational the idea of checks and balances where science, technology, and government mesh or collide. They are a prime vehicle for public service and a versatile and often indispensable means of improving public choices. This examination of the sector as a whole impresses us with the need for civility in American society, for the willingness to accept decisions reached by accepted procedures, if pluralism is to produce its greatest benefits.

We record our appreciation for the imaginative and insightful efforts of the members of the Task Force on Nongovernmental Organizations, its co-chairs, William D. Carey and Charles McC. Mathias, and its study director, Jesse H. Ausubel. We note that the Task Force benefited in the initial stages of its endeavor from the experience and wisdom of Ivan L. Bennett, Jr., a great physician and educator, who unfortunately died in the spring of 1990. Ivan exemplified many of the best values that are the underlying reasons for this report.

William T. Golden, Co-Chair
Joshua Lederberg, Co-Chair

PREFACE

This report of the Carnegie Commission on Science, Technology, and Government was prepared by the Task Force on Nongovernmental Organizations in Science and Technology, co-chaired by Charles McC. Mathias and William D. Carey. The Task Force was formed in January of 1990 with the charter to illuminate the role of S&T NGOs, to identify their competences and limitations, and to scan opportunities to position these organizations and their perceived strengths for greater individual and collective impact on, and service to, the various branches of government.

The Task Force placed heavy reliance on individuals knowledgeable and experienced in the subject area, and drew on commissioned papers, oral presentations, and available data and published reports. It met four times for interchanges and probing debates during which there was ample ventilation of views, favorable and critical alike, on the strengths, utilities, bounds, and anomalies of nongovernmental organizations as catalysts for resolving dilemmas in the relationships of government with science and tech-

nology. A preliminary meeting organized by the Commission in June of 1989 to explore the subject of NGOs helped to structure the effort. A small workshop on Science and Technology and the Democratic Process, held in July 1991, provided further useful input.

The Task Force benefited greatly from background papers prepared for it on several subjects:

- "The Role of Nongovernmental Organizations in S&T Policy Making," by Clifford Berg
- "The National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and the National Research Council," by Dael Wolfle
- "Federally Funded Research and Development Centers," by Clifford Berg
- "The Role of NGOs in Improving the Employment of Science and Technology in Environmental Management," by Charles Powers
- "NGO Programs of U.S. Research Universities," by Franklin A. Long
- "Advocacy Organizations in the Formation of Science and Technology Policy," by Marc Rotenberg
- "The Role of NGOs in Improving Science and Mathematics Education," by Marcia Sward, Lilli Hornig, and Oakes Ames
- "Science and Congress: Essays by Former Congressional Fellows," edited by George C. Sponsler

The borders of a study on S&T NGOs are necessarily fuzzy. The study might, for example, have addressed the relations of the government with science museums, universities, hospitals, and private foundations. Such relations may well undergo important adjustments in coming years and thus deserve careful consideration, but they are for the most part outside the focus of this report. The report also does not deal with the numerous associations, such as the Chemical Manufacturers Association, formed by groups of firms in the various sectors of private industry, though these often promote science and technology and certainly seek to influence government. The report touches upon selected facets of universities as NGOs, but it does not address the more general question of how the capacities of universities could be used to enhance governmental decision making.

The emphasis of the report is on NGOs that typically are independent, membership-based, multipurpose, self-governing, and self-financed, with an orientation toward affecting governmental choices involving science and technology. While most examples relate to NGOs involved in natural

sciences and engineering, the arguments also bear on organizations such as The Brookings Institution or the American Enterprise Institute whose programs rely on the social sciences; such NGOs bring a great deal to the interface of research and technology with ethics and values.

S&T NGOs are active and growing not only within the United States but within other countries and internationally. Moreover, many U.S. NGOs are actively implementing programs to apply science and technology for development within less-developed countries. NGOs are increasingly influential in the decision making of the United Nations and other intergovernmental bodies. This report focuses on the domestic role of U.S. NGOs. However, many of the points in the report apply to the conduct of NGOs internationally. International roles of S&T NGOs are also explicitly discussed in two other Commission reports, *International Environmental Research and Assessment: Proposals for Better Organization and Decision Making*, and *Partnerships for Global Development: The Clearing Horizon.*

Among those who assisted the Task Force were Lester Brown, Yaron Ezrahi, Emilio Daddario, Anne Keatley, Spurgeon Keeny, Geraldine Mannion, Helga Nowotny, Robert Park, John Perry, Alan Pifer, Jurgen Schmandt, Maxine Singer, H. Guyford Stever, and Norman Waks. Roy Goodman, Librarian of the American Philosophical Society, was also most helpful. The report was drafted principally by William D. Carey and Jesse H. Ausubel, the Commission's Director of Studies, and was edited by Jeannette Lindsay Aspden. Members of the Commission and its Advisory Council provided significant inputs for the final report. Margret Holland, Doris Manville, and Alexandra Field made many practical contributions to the success of the project. The Commission's Executive Director, David Z. Robinson, offered valuable suggestions and consistent encouragement throughout the effort.

The report is endorsed by the Task Force and was approved by the Commission at its January 1992 meeting.

EXECUTIVE SUMMARY

Nongovernmental organizations in the United States display a striking variety of forms, characteristics, and roles. Situated in the "independent sector," they pursue a multitude of interests and goals, as often divergent as convergent. Pluralism thrives in this setting. While pluralism serves the civic ideal of checks and balances, it also harbors a proclivity toward divisiveness and disorder in public policymaking.

The Task Force has not found it easy to isolate the scientific and technological (S&T) subset of the vastly larger nongovernmental organization movement. For purposes of the present study, the subset includes those societies, associations, academies, and institutes with primary memberships of scientists, engineers, and researchers; Internal Revenue Service 501(c)(3) tax-exempt status, which severely limits overt lobbying activities; a strong interest in providing rigorous technical input to governmental decision making; and independent, often elected, governing bodies. Allowing for judgments in definition and classification, there are between two thousand

and four thousand NGOs of the core S&T kind. The Task Force also includes certain S&T enterprises, notably federally funded research and development centers (FFRDCs), because of the independent character of their governance and accountability, notwithstanding the special relationship these centers have with government sponsors. (See Appendix A for descriptions of 21 NGOs that are important to science and technology.)

The Task Force's assignment from the Carnegie Commission was "to sift evidence and experience of a cross-section of NGOs leading up to an assessment of the potentials of independent science-and-technology-oriented organizations for constructive and timely initiatives at the point where science and technology intersect with government." Other task forces of the Carnegie Commission have made the case that scientific and technical considerations now enter heavily into government's multiple agendas—domestic, international, economic, military, and regulatory—while the structures and processes in place for policy management do not optimize the absorption and use of scientific and technical advice.

The sense of this Task Force is that the independent and diverse expertise of NGOs is a significant and renewable resource that government should take advantage of more fully. The Task Force's findings point to impressive NGO capabilities for enhancing and mediating interactions between science and technology and government, while emphasizing that such activities lay nontrivial responsibilities upon NGO governing bodies. The public policy process is properly sensitive to the appearance of self-interest or organizational bias in policy research and technical advice to government.

RECOMMENDATIONS

In light of these findings and observations, the Task Force makes the following recommendations:

- **Self-evaluation of NGOs as they relate to government.** The Task Force calls the attention of NGO leadership bodies to the need for timely review of their missions, priorities, goals, and performance with respect to government. It also calls upon NGOs with an interest in a systematic advisory role on issues before government to attend rigorously to the integrity, quality, and supportability of their studies, reports, and testimony. (See pages 39–44, 52–54.)

- **Stronger coordination among S&T NGOs.** The Task Force urges that the prevailing diffuseness and organizational autonomy marking the

NGO enterprise be addressed by cooperative networks, coalitions, and consortia and by the sharing of expensive analytic resources. (See pages 22–24.)

■ **Emphasis on precollege science and math education.** The Task Force expresses the strong conviction that during the next decade improvement of precollege science and mathematics education for all citizens should be the primary mission of S&T NGOs as a whole in their efforts to affect policy at the national, state, and local levels and that every S&T NGO should consider its potential roles in this area. (See pages 64–66.)

■ **Expansion of programs of resident S&T fellows in government.** The Task Force calls for growth of NGO science and technology fellows programs in the Congress and the Executive Branch and for the extension to the states and possibly the Judiciary. (See pages 44–47.)

■ **Strengthening the foundations of S&T policy studies.** The Task Force calls for new efforts to inform, cohere, and support the field of policy research in science and technology. Leading governmental users and practitioners of policy analysis should work with NGOs and universities to help define the agenda for policy research, analysis, and design; agree on how it will be supported; and promote arrangements to encourage the cumulative learning that can help advance the craft. (See pages 54–57.)

■ **Strengthening the National Academy complex.** The National Academies of Sciences and Engineering, the Institute of Medicine, and the National Research Council, together comprising the National Academy complex, are uniquely influential in the universe of S&T NGOs. The Task Force commends the Academy for its record of remarkable advisory services to government, while expressing concern lest the demands on the Academy complex work to the detriment of its unique capacities; it counsels the Academy to review the balance of its program and the adequacy of its structure and resources given the heavy calls on its advisory services, as well as emerging needs and opportunities. (See pages 57–60.)

■ **Adaptation of quasi-nongovernmental organizations to meet new needs.** The Task Force acknowledges the significant roles played over more than four decades by quasi-nongovernmental organizations (quangos). Quangos use their special relationship with government agencies to offer objective advice on complex scientific and technological choices in both national security and civil research and engineering. The Task Force urges that broad-based FFRDCs explore suitable transitional roles and missions as the defense complex is downsized, adapting their high-grade policy research skills to the needs of contemporary society. The Task Force also notes the incipient success of a new type of public/private NGO in acting as an interface between governmental regulators and affected sectors of industry to alleviate gridlock arising from scientific, technical, and economic risk and

uncertainty. The Task Force recommends examination of this model for adoption in other regulatory contexts. (See pages 26–28.)

■ **Partnerships of NGOs with new levels and branches of government.** The long-standing relationship between government and science and technology on the national level is finding a match at the state level, but few states yet have the technical and analytic resources to address the problems they face. Finding ways to reinforce the technical capability of state governments should constitute part of the emerging agenda of nongovernmental S&T groups; in particular, there may be new challenges for state academies of science, engineering, and medicine (see pages 60–62). Opportunities should be explored with the judicial branch as well (see pages 62–64).

A CHANGED PARADIGM

In the face of the unmistakable growth of scientific and technical NGOs, the Task Force suggests that the United States has experienced a structural shift and a realignment of the postwar framework within which the relationship of government with industry and academia took form. That three-dimensional paradigm appears to have undergone a change with the emergence of NGOs as a fourth dimension. The roles open to scientific and technical organizations in the independent sector are real, emergent, and compelling.

1
OBSERVATIONS AND COMMENTS

This report seeks to take the measure of the nongovernmental organizations (NGOs) that support or use science and technology heavily, in an effort to enhance the mechanics, systems, and processes through which government strives to make up its mind and conduct its business.

By definition, NGOs arise to occupy niches in the "independent sector" that lies between the well-defined domains of the government and those of private, profit-making enterprise. From this fertile ground for organizational innovation, NGOs increasingly assist as well as challenge government at critical stages of policymaking. Many NGOs share characteristics as self-governing, self-supporting, nonprofit bodies created to supply a public good. They reach into every domain of our lives.

Scientific and technical societies and associations have been part of the American scene since colonial times. Benjamin Franklin and colleagues established the American Philosophical Society in Philadelphia in 1743 to "promote useful knowledge among the British plantations in America." The

American Academy of Arts and Sciences was established with similar objectives in Massachusetts in 1780, and the New York Academy of Sciences was founded in 1817, around the time that the French traveler Alexis de Toqueville was observing the voluntarism that he felt was one of the distinctive features of democracy in America. The American Association for the Advancement of Science (AAAS) originated in 1848, and Sigma Xi was founded in 1886 as an honor society for scientists and engineers.

EARLY RECOGNITION OF S&T'S IMPORTANCE TO THE NATION

S&T NGOs thus long predate the involvement of government in massive support of research and its applications, as well as the political awareness of the links between science and technology and the nation's salient goals and its success in achieving them. That awareness has, however, grown.[1] One proof of the growing recognition of the importance of these links is that the United States gradually created *governmental* scientific and technical bodies directly under its own auspices for a broad range of purposes. Early examples were the U.S. Naval Observatory in the 1840s, the Smithsonian Institution (1846), and the Geological Survey (1879). Through the Morrill Act (1862), the government encouraged the creation at the state level of "land grant" universities devoted to mechanical and agricultural arts.

World War II opened the modern era of intense interaction between S&T and government carried out through a multiplicity of arrangements and relationships. By the present day almost every department of government from Agriculture to Veterans' Affairs has become deeply engaged with applications of S&T and relies on a combination of in-house and outside expertise to carry out its work and steer its course. There has been an extraordinary growth of governmental agencies and parts of agencies centrally concerned with S&T. These include the White House Office of Science and Technology Policy, the National Science Foundation, the National Institutes of Health, the Defense Advanced Research Projects Agency, and the plethora of national laboratories concerned with energy, environment, space, national security, and other subjects.

The growth of the government's internal capacity is only one part of the general growth of the role of science in human affairs that has taken place in the United States. In fact, of the approximately 1 million scientists and engineers employed in research and development activities in the United States, only 7 percent are direct employees of the government; 75 percent work in industry, 14 percent in academia, and 3 percent in other nonprofit

institutions.[2] America has traditionally been cautious in assigning roles and responsibilities to the federal government and has instead encouraged the growth of the private sector in all its forms. This preference is reflected in the distribution of scientific and technical expertise and in the institutional arrangements designed to enable science "to speak truth to power."[3]

SCIENCE AND GOVERNMENT: THE FOUNDATION OF THE ACADEMY

An early recognition of the value of an independent scientific community existing in close contact with government occurred in 1863, when Congress chartered the National Academy of Sciences (NAS) as a private, nonprofit, self-governing membership corporation (Figure 1). While one of the Academy's functions was simply to further knowledge, another was explicitly to provide independent advice to the federal government. The Academy's consultative role would grow, and in 1916 the National Research Council (NRC) was established as the principal operating arm of the NAS; the goal was to enlist the broad community of professionals in science and technology in advisory activities. Along with the elected Members of the NAS and its sister acad-

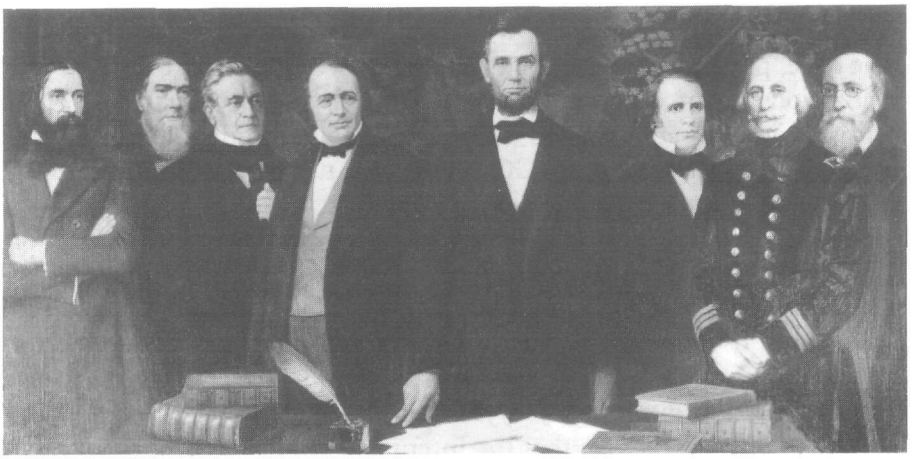


Figure 1. The founders of the National Academy of Sciences with Abraham Lincoln in 1863. From left to right: Benjamin Peirce, Alexander Dallas Bache, Joseph Henry, Louis Agassiz, President Lincoln, Senator Henry Wilson, Admiral Charles H. Davis, and Benjamin Apthorp Gould. The original, painted by Albert Herter, hangs in the Board Room of the Academy. (Reproduced from the collections of the Archives of the National Academy of Sciences.)

emies, the National Academy of Engineering (founded in 1964) and the Institute of Medicine (founded in 1970), many thousands of volunteers now participate each year in the activities of the National Academy complex, primarily through the National Research Council.[4]

In recent decades, reflecting both concern about directions of public policy and continuing public pressure for limited government, there has been an extraordinary growth in the United States in the size and number of NGOs, and not only in science and technology. They organize talents and interests, pervade policymaking, and fill our mailboxes.

Yet, what is the nature of the accountability of NGOs, and where are they likely to fit in the scheme of democratic institutions in the United States in the coming decades? These questions form the core of the present inquiry. The behavior, characteristics, and even incongruities observed in the formation of S&T NGOs call for comment. Most important are the roles exercised by such organizations in strengthening the capacities of the policymaking machinery to deal with problems of public choice in which scientific or technological considerations have importance. Put another way, the inquiry addresses the extent and quality of the added value represented in the interactions of S&T NGOs with government.

DIFFICULTIES IN GENERALIZATION

The scale, proliferation, and pluralism of the NGO universe constrain generalizations about capacity, quality, and institutional objectivity.[5] These same factors also set bounds to the practical range and depth of data gathering and evaluation about NGOs. Moreover, turbulence is built into the universe of voluntary organizations.

The 501(c)(3) Internal Revenue Service category of tax-exempt organizations (which bestows privileged status for organizations directed at the civic good but largely precludes lobbying) alone blankets 505,486 separate enterprises as of 31 August 1992. According to Independent Sector, an organization that assists and monitors NGOs, no fewer than 30,000 new arrivals signed in during 1989–1990, making a net gain of 110,000 organizations over five years.[6] Neither the Internal Revenue Service nor Independent Sector has solved the headaches of species definition and classification. Because of their multipurpose claims, we can venture little more than a rough estimate that the "scientific and technical" cohort might be in the range of two to four thousand organizations. Clearly, such a situation raises

cautionary flags in reaching generalizations about the universe as a whole. The rough typology offered later in this report reinforces the point that understanding NGOs is a matter of appreciating diversity as much as recognizing common traits.

WHY BE CONCERNED NOW?

If there is now a more compelling case for ordered and responsible inputs to government from the scientific and technical cohort of the independent sector, it is framed by a confluence of pressures. These challenge science's expectations for long-term growth in public investment for research, applications, and infrastructure. Should these pressures be prolonged, or worsen, at least two sets of relationships are bound to suffer: the bonds that have represented a working partnership between S&T and government; and the civilities that undergird comity between and among fields and disciplines in research.

Troubling signs of divisiveness and questionable pleading of special interests, manifestations of alarm in the academic research community, disappointment at the nonappearance of a peace dividend to reignite the sciences, and dissatisfaction with support allocation processes—these add up to developing discord. For NGOs they present a choice of being part of the problem or part of the solution. In short, the NGOs are being tested for stamina and vision in the presence of stresses within the policymaking system.

What is stressing the policymaking machinery is all too evident: global political change, which calls organizational goals into question; national and global economic restructuring, which affects revenues; increasing global interdependence, which affects the autonomy of domestic organizations; conflicting concerns about the hazards of technological progress and economic growth; limits on the government's discretionary budget, which is the source of most support for research; priorities competing in the queue for resource allocations; the sheer number of dollars needed for some kinds of scientific advance; accruing backlogs for modernization of the research infrastructure; and structural barriers to the formulation of mid- and long-range goals for science and technology with relevance to societal purposes and needs.[7] There is the possibility that NGOs, like many sectors of American society, may have expanded in a speculative boom in the last decade or two, and that a period of contraction and consolidation lies ahead in response to the confluence of pressures.

ON DIVERSITY

The range and variety of NGOs in science and technology is equaled by their proclivity to breed, to subdivide, and to attract transient members from related fields and interest sectors. In these terms the NGOs display energy, vitality, and a legitimacy that is attested to by the evidence of overall membership numbers and income streams, though many individual NGOs suffer acutely from fiscal malnutrition. The population of S&T NGOs runs from broad-spectrum, general-purpose scientific and technical organizations to honorific self-selected academies, and from there to an extensive array of discipline-specific societies and advocacy groups.

NGOs flourish from the grass roots of the National Wildlife Federation to the Olympian heights of the National Academy of Sciences. Short of attempting a full census, the variety of S&T NGOs begins to express itself in the inventory of "affiliated organizations" of the American Association for the Advancement of Science (AAAS), totaling nearly 300. Yet this list (Appendix B) omits such significant players as the National Academies, Resources for the Future, the World Resources Institute, the Federation of American Scientists, the Health Effects Institute, the Union of Concerned Scientists, and the Association of American Universities. Neither does the AAAS umbrella cover leading university-based science and technology policy-studies centers, nor the important "quasi-nongovernmental organizations" (quangos), such as the RAND and MITRE Corporations, that are discussed later in this report.

As a collective universe, the NGO enterprise in science and technology exhibits structural features of its own that mirror those of American government. It is not an assembly of like-minded adherents or interests. Rather, it carries pluralism to its outer limits, maximizing organizational autonomy while minimizing convergent strategies and behavior that could focus science's colloquies with government. The result is that government can only partially make connections with NGOs, and then mainly with major entities whose views may represent only a fragment of the opinion spectrum. Still, the Task Force does not call for the fusion of thousands of NGOs. It does take the position that the consequences of organizational fragmentation may cost science and engineering a good deal of their potential effectiveness.

■ *Effectiveness in relating to government through initiatives for cross-affiliation, networking, and joint meetings and consultative practice should occupy the serious attention of leaders of the NGO movement.*

There are many areas in which NGOs could share resources, especially in research and fact-finding, where they would not compromise their

independence. The Task Force urges NGO governing bodies to coordinate with affinity organizations in the interest of reducing the entropy characteristic of the general NGO scene.

■ *In particular, the principal general-purpose and federative NGOs concerned with science and technology, such as the American Association for the Advancement of Science, Sigma Xi, and the Council of Scientific Society Presidents might extend their interorganizational networking and cooperative initiatives.*

Intersociety efforts of the AAAS already include the annual report on research and development in the federal budget in which more than 20 groups participate, as well as a 75-member intersociety consortium for developing economies. Sigma Xi and five other scientific societies cosponsored a major forum intended to support and deepen the discussion at the June 1992 Earth Summit in Rio de Janeiro.[8] The World Resources Institute provides valuable services on the subject of sustainable development to a diverse community worldwide through its "NGO Networker" newsletter. The AAAS might, for example, also institute a multi-NGO conference process on standards and quality assurance for studies and reports to government users.

The engineering community as a whole and the dozens of specialized professional engineering societies have had more difficulty than the scientific community in finding an organizational forum through which they can act together comfortably and effectively on matters of common interest. The American Association of Engineering Societies (AAES) has had an uneasy existence as the umbrella organization for the engineering professional societies. Partly this is simply the result of the greater heterogeneity of the engineering profession. Partly it may be attributable to the absence of a professional journal in engineering equivalent to *Science*, which provides the spine for the AAAS.

There are, however, cross-cutting organizations and activities in engineering as well as successes of the AAES that demonstrate the potential of cooperative approaches. The Industrial Research Institute is an impressive example of an NGO set up to overcome structural impediments to cooperation within industry. The annual convocations of the engineering professional societies with the National Academy of Engineering provide useful occasions for exchange of views on issues of shared concern, such as engineering education, international standards, intellectual property rights, and national technology policy.

■ *The leaders of the engineering community should meet to explore the adequacy of present mechanisms for joint activities in relating to government.*

There have been important successes in NGO coordination outside the S&T area that may provide useful examples. These include the collaborative agreement among virtually all the major conservation groups to work together through the League of Conservation Voters and the monthly meetings of the ten largest U.S. environmental organizations. It is a strength of American culture that people can come together to work out alliances as needed, a strength perhaps not as fully utilized with respect to science and technology and government as it might be.

A CAUTIOUS TYPOLOGY

Many NGOs are multiform in makeup and unlikely to sit comfortably in any particular niche. Nevertheless, a classification is helpful to consider avenues for improvement. Eight leading descriptors of NGOs have surfaced in Task Force discussions. Of course, more than one descriptor will apply to almost every NGO.

- *Honorific*, exemplified by the National Academies of Sciences and Engineering, the American Academy of Arts and Sciences, and the American Philosophical Society
- *Consultative*, e.g., Industrial Research Institute, Council of Scientific Society Presidents, Association of American Universities
- *Federative*, e.g., American Association for the Advancement of Science, Federation of American Societies of Experimental Biology, American Association of Engineering Societies
- *Advocacy*, e.g., Worldwatch Institute, World Resources Institute, Natural Resources Defense Council, Scientists and Engineers for Secure Energy, Computer Professionals for Social Responsibility, Business Executives for National Security
- *Disciplinary or professional*, e.g., Institute of Electrical and Electronics Engineers, American Chemical Society, American Physical Society, Optical Society of America
- *Representational*, e.g., National Science Teachers Association, Association of American Medical Colleges, Association of Women in Science
- *Policy-centered*, e.g., Institute of Medicine, Resources for the Future, Council on Foreign Relations, Harvard Center for Science and International Affairs, George Washington University Space Policy Studies Center
- *Quasi-nongovernmental* (quangos), e.g., Argonne National Laboratory, Aerospace Corporation, MITRE Corporation, Health Effects Institute

Some other relevant features by which S&T NGOs may be classified include

- Whether they were established at the initiative of government
- Whether they see their main purpose as serving government or their own membership/profession
- Whether their programs are largely driven by requests and needs of government or whether they are self-driven
- Whether they are associated most closely with academia, industry, or a mixture
- Whether they solicit or select their members
- Whether they are more concerned about the health of the S&T enterprise *per se* or about outcomes and decisions using S&T
- Whether they are general-purpose groups addressing numerous issues or are specialized in a small number of areas
- Whether they perform research or focus on processes of synthesis, consensus formation, and diffusion of knowledge

FORMS OF ACTION

Variety in physiognomy is matched by the variety of ways NGOs get the job done. Some act as technical backups to government. Some are impressive as conveners, catalysts, and mediators. Some are forceful policy advocates. Those willing to forgo the benefits of 501(c)(3) status can openly become formidable lobbying organizations. Some prefer to work the corridors of the Congress; others prefer the executive branch, the courts, or public and mass media. Some are generalists in science and technology, while others take pride in narrow specializations.

Some apply large resources to journals or other publishing and broadcasting for purposes of scientific reporting and public information. Some work without publicity. Some are involved in close-range tracking of volatile policy issues affecting their constituencies. Some refrain from a public role unless they are aggressively sought out. Others take initiatives both in proposing policies and in action. Some NGOs focus on the individual, for example, taking proactive roles on behalf of underrepresented minorities and as intervenors for victims of human rights infringements. Some thrive on litigation and class-action lawsuits. Others, such as the Council on Com-

petitiveness, work to improve the policy environment for American firms, universities, and other large-scale social organizations.

NGOs in some instances are wary of politicization; others engage in it head-on. Some NGOs, notably the National Academy complex, tackle dilemmas and problems of choice in science, technology, or medicine with highly codified processes intended to prevent prejudgment of outcomes and to authenticate facts. Others react from predictable predetermined positions.

QUANGOS

Some steps removed from the crowded legion of recognizably "nongovernmental" organizations are a cluster of scientific and technological organizations of substantial scale and resources, whose dual status as government-sponsored but contractor-operated (or separately owned) not-for-profit R&D enterprises causes them to be termed "quangos" (quasi-nongovernmental organizations).[9] These organizations have a special relationship with sponsoring government departments while maintaining independent governance and not-for-profit status with strong safeguards against conflicts of interest. Agencies as diverse as the Navy, the National Science Foundation, the Nuclear Regulatory Commission, the Agency for International Development, and the Department of Education have experimented with quangos.

Federally Funded Research and Development Centers

Some forty of these organizations are formally called Federally Funded Research and Development Centers (FFRDCs). They comprise a mix of systems engineering companies, government-owned but contractor-operated national laboratories, and studies and analysis groups (Appendix C).[10] Barred from ties with the firms that supply equipment in the areas that the FFRDCs' analyses might influence, FFRDCs provide their government sponsors with a wide range of technical know-how and offer support to decision makers obliged to make informed choices among advanced technologies and systems. In addition, they may perform independent research of a long-range and high-risk character. The RAND Corporation was one of the early quangos and is now among the most diverse (Appendix D).

As formidable and—by current standards—generously funded enterprises, the FFRDCs are arm's-length instrumentalities providing a versatile and flexible resource for both the national security agencies and, increas-

ingly, the civil functions of government. In terms of comparative behavior, they take their cues from their special relationship and keep a low media and political profile as an expression of issue-neutral expertise. They are envied for their competitive advantage in recruiting and compensating highly skilled scientists, engineers, and systems analysts, as well as for their built-in and controversial priority status as claimants for budgetary resources. The quangos occupy a dimension peculiarly their own in the structures that have evolved for government's technological policymaking.

To maintain their privileged position, there must be periodic examination of the functions and activities of FFRDCs to assure that these could not be fulfilled at comparable quality and cost by ordinary for-profit consulting firms or by government agencies or bureaus. A year-long study by the Subcommittee on Oversight of Government Management of the Senate Committee on Governmental Affairs[11] concluded that "FFRDCs perform a valuable function for our country; they are a priceless source of acumen and talent." It reiterated that "the most prized attributes of an FFRDC are its outstanding staff and a reputation for providing objective advice—being willing to tell an agency the unvarnished truth about an issue, even if the agency doesn't want to hear it." The report also found that FFRDCs today operate under an inadequate, inconsistent patchwork of federal cost, accounting, and auditing controls. It is not surprising in such circumstances that the for-profit professional services industry charges inappropriate and unfair reliance by the federal government on FFRDCs. Unsatisfactory supervision of some FFRDCs in turn worsens the threat of micromanagement for all.

New Roles for Old

The Task Force acknowledges the significant roles performed over more than four decades by quasi-nongovernmental organizations through their special relationship with government agencies. Using noncompetitive criteria and maintaining their vigilance against conflicts of interest, they have provided objective advice on highly complex scientific and technological choices and goals in both national security and civil research and engineering.

■ *The Task Force urges that broad-based quangos explore suitable transitional roles and missions as the defense complex is downsized.*

In this regard, we note with interest RAND's Institute of Civil Justice, and the actions of the Ford and Weingart Foundations in enabling RAND to establish its Drug Policy Research Center; in addition, the Lilly Endowment has funded RAND's Institute on Education and Training. These

powerfully illustrate the potential of the independent sector to reorient high-grade policy research skills to serve the changing needs of contemporary society.

The Critical Technologies Institute, funded by the National Science Foundation and operated by the RAND Corporation, was established in 1992 to assist the Office of Science and Technology Policy and other parts of the White House apparatus. This is evidence of the continuing appeal of the quango concept for the provision of independent scientific and technical advice. Some have suggested that the quango concept might be applied more often at the state level as well.

New Kinds of NGO

The Task Force also notes with particular interest the incipient success of a new type of NGO as a bridge between government regulators and the affected sectors of industry.[12] These NGOs have a strong potential as trusted intermediaries in alleviating policy gridlock arising from scientific, technical, and economic risk and uncertainty.[13] The first of these organizations was the Health Effects Institute (HEI), established in 1980. HEI was conceived as a trial strategy for overcoming the adversarial gridlock existing between government and industry over risk evaluations of unregulated auto emissions. The Institute, working from neutral ground and funded equally by both sides, became the agreed-upon independent scientific agent for implementing a stalled requirement of the 1977 Clean Air Act. Its founder points out that this formula is mainly workable where parties in conflict are so dug in as to block achievement of a public interest.

Subsequently, similar organizations have been founded to assist in the cleanup of hazardous waste sites (Clean Sites, Inc., and Resources for Responsible Site Management) and in carcinogenic risk assessment (Institute for Evaluating Health Risks). In addition, a sister organization to HEI has been established to assess knowledge related to asbestos.

The common elements in these organizations are carefully balanced funding responsibilities between the public and private sectors and powerful roles for independent advisory boards of outstanding scientists and engineers acting in their individual capacity.

■ *The Task Force recommends that government, industry, and public interest groups examine the model of public/private bridging organizations for adoption in additional regulatory contexts requiring a stronger base in science.*[14]

MEMBERSHIP AND FINANCES

Matching the variety of NGO structures and roles is the range of participatory membership. While the National Academy of Sciences limits to a fixed number, currently 60, the scientists who may be elected annually in recognition of exceptional distinction, the gates of the AAAS stand permanently open to all dues-paying comers whether scientists or not. Advocacy-type NGOs employ direct-mail methods to recruit members and dues-payers, citing the importance of the causes they espouse. Organizations trade mailing lists and tailor recruitment approaches to demographic research. "Issue politics" has been a force driving the creation of NGOs and swelling aggregate membership. So has the definition of new sectors in science and engineering, as well as social concerns about conduct in research and the pressure for accountability.

RECENT TRENDS

Membership, however, is migratory and to a degree temporary in the case of NGOs, with even the mainline organizations concerned about retention rates and seeking appropriate inducements. A scanning of the *Encyclopedia of Associations* from year to year bears out the claims for both organizational

Box 1. Membership in Selected Environmental Groups, 1980 to 1989

Group	1980	1989	Average yearly increase (%)
Defenders of Wildlife	44,000	80,000	9
Environmental Defense Fund	45,000	100,000	14
National Audubon Society	412,000	575,000	4
Natural Resources Defense Council	42,000	117,000	20
Sierra Club	180,000	496,000	20
Wilderness Society	45,000	317,000	67

Source: Robert C. Mitchell (1990), "Public Opinion and the Green Lobby: Poised for the 1990s?" in N. J. Vig and M. E. Kraft (eds.), *Environmental Policy in the 1990s: Toward a New Agenda*, pp. 81–99, Washington, DC: Congressional Quarterly.

and membership growth over time. It also raises conceptual and definitional headaches for a researcher attempting to classify what resists classification. Although multiple affiliations doubtless go far to swell the totals, aggregate membership claimed for "scientific, engineering, and technical" associations tops out at roughly 16 million.

Environmental NGOs, which all have scientific facets, increased their memberships at an extraordinary rate during the 1980s (Box 1). In 1990 and 1991, however, they experienced fluctuations in membership, staffing, and budgets. For example, Greenpeace USA (which grew at 30 percent per year in 1985–1990) and the National Wildlife Federation had level or reduced funding and staffing in 1991, while the budget of the Natural Resources Defense Council increased by 5 percent.

It is not too much to speak of an "NGO movement" in recent years, in which the United States leads the world, but which has become a powerful force nearly everywhere, as outlined later in the report's discussion of the "International Dimension" (pages 71–73).

Science and Technology NGO Resources

Reported but unverified S&T NGO resources in the United States raised from private and public sources approach $1 billion per year, without including FFRDCs, contract laboratories, or university S&T policy centers. While the financial resources are spread over thousands of organizations, perhaps a dozen NGOs account for over half the total. The rich and poor together populate the neighborhoods of the NGO universe. Scores of small and vulnerable entities scratch to exist with reported revenues under $25,000, while some major NGOs operate in the $200 million or greater annual range, with a good portion of that intake deriving from publishing operations, services, contracts, and grants. But strength of NGOs must be measured in several dimensions besides budget, including size and clout of membership and staff and ability to mobilize public opinion.

Although we are speaking of "nongovernmental" types of organizations in the "independent" sector, ambiguities inevitably come to the fore. Indeed, three-fourths or more of the revenues of some significant entities have come from government year after year in steadily increasing amounts. Overresponsiveness to funding agencies is no less a threat than starvation to long-term credibility and performance. It is no accident that Washington, DC, is the "association" headquarters of America, and that in recent decades numerous NGOs have relocated their own main offices to Washington, or have opened Washington offices.

Soft and Hard Money

Few scientific and technical NGOs have no money worries. A handful do very well indeed, but most organizations have their hands full making ends meet. For the most part, the NGOs rely on a combination of revenues, on variable mixes of hard and soft income. Hard income derives from membership dues, charges for journal subscriptions, revenue from advertising in NGO publications, and earnings from endowment or invested resources. Even that array of revenue streams should not be assumed to be flexibly at the disposal of most NGOs. Soft income is revenue that NGOs are obliged to pursue through the toils of government procurement procedures or the increasingly congested channels of grant assistance.

As a generalization, hard money underwrites governance and core activities of NGOs, while elective or optional program activities depend on grant and contract support. Shrinkage in the supply of government contract and other kinds of money results in swelling the demand on foundations, industry, and individual philanthropy. Hard money, for that matter, is not that much more dependable as member recruiting falls off, dues are not renewed, advertising slumps send publications to the wall, and interest on investments falls as rates are lowered. Happy is the NGO with a product line or publication sufficiently immune to downturns of the business cycle as to assure the organization of an uninterrupted flow of financial oxygen.

Both the stabilities and the exposures of a well-positioned NGO may be observed from a glance at the yearly statement of revenues and expenses for the AAAS in its annual *Handbook* (Box 2). Immediately noticeable is the preeminence of the weekly journal *Science* in AAAS's financial experience and outlook. It accounts for over two-thirds of realized income (recognizing that the flow of member dues is in large part for subscription to *Science*), and in that sense is the stabilizing factor around which plans can be made and decisions taken. Of almost as much interest is the acknowledgment of more than 100 separate grants to AAAS, representing nearly a quarter of reported revenues. To be sure, this tells us that soft money plays a lesser role in AAAS's financial setup, and to that extent its exposure is moderate compared to the lot of more typical NGOs, which depend largely on soft support. The role of soft money is not so small, however, in the eyes of those who see program activities at risk, while the share of resources going to *Science* is sheltered.

Soft money, in short, enables NGOs to do the kind of things implicitly expected of them as educational and public service organizations holding tax-exempt status. It is what NGOs queue up for in the doorways of foundations and agencies: to finance efforts at reform of science teaching,

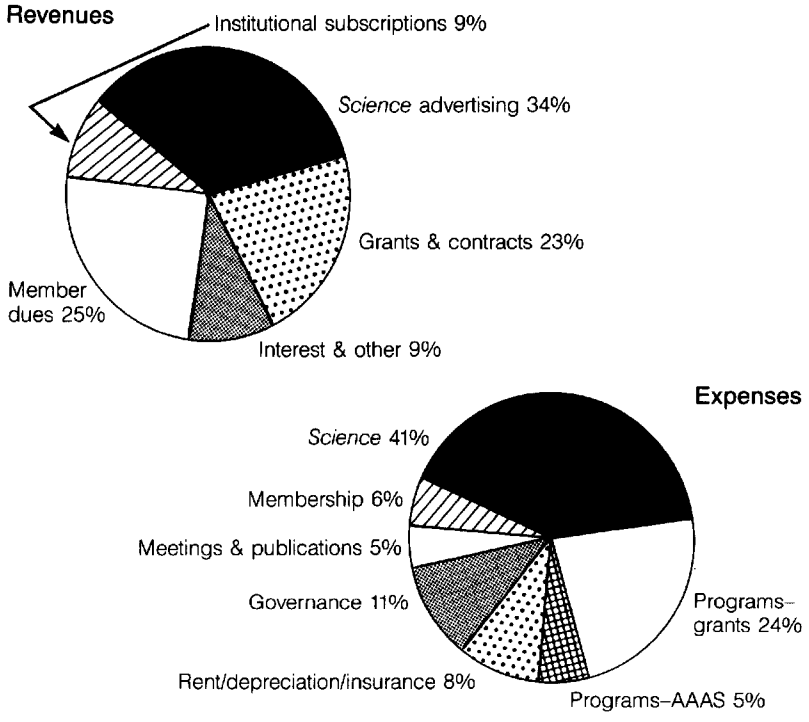
Box 2. 1991 AAAS Summary Budget

REVENUES

Member dues in 1991 provided $9.7 million for the support of *Science* and other AAAS activities, and institutional subscriptions and advertising in *Science* provided another $3.5 and $13.2 million, respectively. AAAS program activities recognized revenue of $9.0 million on over 100 separate grants in 1991, while interest and other income provided another $3.6 million. Total 1991 operating revenue was $39.5 million, versus expenses of $38.5 million.

EXPENSES

Of the total 1991 operating revenue, $15.9 million was applied to produce and distribute *Science*, and $2.4 million was used to develop and maintain membership. Meetings and publications other than *Science* received $1.9 million, and governance and administrative activities required $4.2 and $3.2 million, respectively. AAAS Directorates received $1.7 million from Association funds and $9.0 million in grant funds to carry out existing and new programs in science education, international, and science and policy activities.



100% = $39,466,394 (*1992, unaudited*)

Source: AAAS *Handbook*, 1992.

public literacy, government and media fellowships, science policy studies, human rights activities, and initiatives for international linkages on behalf of environmental sustainability. It is the elasticity of demand and supply in the soft money sector that spells promise or disappointment as NGOs face opportunities to play value-added roles with governments in areas related to science and technology.

In some contrast to the substantial income and outgo of AAAS, its sister NGO for engineering, the American Association of Engineering Societies (AAES) must make do on an annual budget of $1.5 million, a third of which comes from dues paid by participating societies and the rest from publication revenue and grants or contributions.[15] As an aside, in noting that AAES participating societies pay dues, it may be observed that dues are not levied by AAAS on its 300-odd affiliated societies (see Appendix B), many of whose own members are among the 130,000 individual dues-paying AAAS members.

Cross-Membership

Cross-membership in both an individual's generic scientific or engineering society and one or more of the general-purpose NGOs or an advocacy organization can be as expensive as it is rewarding. The rewards include access to a variety of platforms, forums, information arrays, bulletin boards, travel opportunities, and contacts. In terms of organizational benefits, there are opportunities for economies of scale in regard to accessing audiences and drawing on data banks and analytic advantages. Multiple individual memberships, on the other hand, make it hard to know whom you are counting when attempting to verify claims as to size of constituency. Moreover, when economic times are hard, the NGO of secondary or tertiary interest tends to be the one receiving notice of membership nonrenewal, whereas that NGO may have built plans and cost commitments on the misinterpreted "strength" of its marginal member cohort.

Soft Money—The Risks of Dependency

What can befall an NGO dependent on soft money is illustrated by the experience of the International Institute for Applied Systems Analysis (IIASA). IIASA is an international NGO launched hopefully by U.S. and Soviet founders around 1970 to study common problems of industrialized societies. The superpowers (along with a number of lesser powers) agreed to pay the costs, channeled through domestic scientific organizations. The U.S. member organi-

zation was the National Academy of Sciences; it is now the American Academy of Arts and Sciences. The optimism proved short-lived when the U.S. Government shut off its support for IIASA in the early 1980s for reasons of foreign policy, leaving the enterprise on desperately short rations and the American Academy to collect what coins it could from private foundations to save face for the United States. The shift from superpower confrontation led to a resumption of U.S. Government support in 1989, but not before the melodramatic fluctuations and uncertainty about funding had lessened the performance and potential of IIASA. This tale illustrates the increased threat from reduced federal funding that has come with the growth of partnerships between the federal government and the independent sector.

In distinctly better shape as an NGO, Resources for the Future functions as a research-intensive organization with a focus on applied and fundamental research on basic resources of land, water, minerals, and air together with environmental and energy-related policy analysis. Without a membership base, RFF's revenues of some $8 million annually have come in roughly equal shares from endowment, government grants, and corporate and foundation contributions. Soft money is perhaps less worrisome for NGOs when an organization has four decades of systematic analytic work behind it and when its style and habit of objectivity create a funding preference for it in the foundation and corporate sectors.

The Academy Complex—a Special Case

Inevitably we return to the National Academy complex as an NGO, albeit one holding a special relationship with government that provides dependable flows of federal funds and, as a consequence, raises the dilemma of perceived dependency on government. Upwards of 75 percent of the complex's expenditures come from federal sources; the rest, from endowment and private sources, now represents a rising factor in the Academies' balance sheet. With annual outlays approaching $200 million, the scale of NAS–NAE–IOM–NRC funds available for scientific and technical studies and services to governments, including policy research and technical assessments, puts the Academy complex in a class by itself among NGOs. It is a phenomenon that must be explained as a function of the "special relationship" created by the congressional charter, the NRC's reputation for quality assurance and product acceptability, and, by no means least, successful enterprise by its staff officers.

INTERNAL DYNAMICS OF THE NGO COMMUNITY

We have no way of telling to what extent special-interest or advocacy NGOs have helped or hurt the financial expectations of the scientific and technical NGOs that mute or balance their political biases. The former organizations appear to employ more effective fund-raising methods and messages than their more sedate brethren, at least in the short run. To the degree that they succeed, it may be to the disadvantage of nonadvocacy groups, which find high-pressure methods distasteful. Competition for membership and sponsors may provide dysfunctional pressures for "viewing with alarm" and exaggeration. However, it may also be argued that the more balanced or mainstream organizations live symbiotically with their alarmist neighbors. The internal dynamics of the NGO community are not yet well understood.

As the universe of tax-exempt organizations continues to expand and to seek constituencies already attached to existing organizations, while pressing funding enterprises for core and program support, the question arises of the size of the total niche for S&T NGOs. With it comes concern for smaller, less viable, and less muscular, but nevertheless well-regarded, centers for scientific and technical policy studies where the accent is on technical and analytic merit rather than on marketing.

In short, funding is an acute and important issue. There is competition and probably more than a healthy amount of distress. Three-quarters of the time of heads of NGOs may go to fund-raising, and their boards may spend 90 percent of their time on finances (Alan Pifer, personal communication). The United States relies more heavily on nonprofit organizations than any other country, but it has not faced up to the implications of this situation for the sustainable and reliable provision of services in areas such as science and technology.

DOES GOVERNMENT VALUE THE PRODUCT?

Generalizations about value are hazardous, given multiple sources of technical inputs to decision making, the ephemeral properties of policy advice to government at its many tiers, and the several functions that technical advice may fulfill. Washington is itself a churning marketplace of advisors and advice, including both the technical and policy-related kinds. But there are signs indicating that government is looking to scientific and technical NGOs for expertise and particular services.

Because of its congressional charter, an obvious index of the government appetite for advice is the level of activity of the National Academy complex, which spans acoustics, aging, and air quality to vaccines, wind tunnels, and the radioactive waste depository at Yucca Mountain (Box 3). Technical and policy-oriented "mandated" studies directed to the National Academy complex are on the increase, frequently on quick-turnaround terms, while at least as much work for government is self-generated by creative arms of the complex. The Academy currently takes on nearly 300 projects per year. NASA has taken pains to acknowledge the value and merits of the National Research Council (NRC) appraisals of aerospace technologies. Classified inquiries come regularly to the Academy complex from the national defense and intelligence agencies. The White House Space Council, chaired by the Vice President, has sought the advice of the NRC before advancing proposed initiatives in the budgeting and appropriation

Box 3. Subjects of Some Recent Studies by the National Academy Complex

National Science Foundation's system for awarding research grants
Feasibility of the National Institutes of Environmental Research
Information on the Alaska outer continental shelf
Cancer risk associated with exposure to hazardous air pollutants
Priorities in global change research
Policy implications of global warming
Reducing the impacts of natural disasters
Malaria prevention and control
Microbial threats to health
Criteria for measuring poverty
Women's health issues
Food labeling
Techniques for the advancement of human performance
Safety and reliability of the Space Shuttle's rocket motor
Assembly and operation of the Space Station
Air passenger service and safety since deregulation
Fuel economy of automobiles and trucks
National interests in an age of global technology
Commercialization of technologies and profiting from innovation
Foundations of manufacturing
Women in science and engineering
Scientific conduct and the responsibility of science

process. An enumeration of the federal funding sources for a given year of the NRC's studies docket goes far toward mapping the government's scientific geography.

Other indicators also suggest value in the market. AAAS-sponsored seminars for members of Congress and their professional staffs are routinely oversubscribed. The Office of the President has given high marks to education reform strategies advanced by a variety of scientific and technical NGOs. In the most trying stages of political tension between the United States and both the USSR and mainland China, government found utility in the informal, science-to-science exchanges and missions carried out by the NGO sector. FFRDCs have been counted on heavily by the defense services for engineering systems architecture basic to effective command, control, communication and intelligence, as well as by civil agencies concerned with the modernization of the national airways system and cleanup of toxic pollution at defense sites. The Environmental Protection Agency relied on the analyses and assistance of environmental NGOs to improve the environmental dimensions of the North American Free Trade Agreement. And the Congress regularly relies on news and analyses from the Environmental and Energy Study Institute.

In the arms control arena, testimony suggests that the government appreciates that groups such as the Arms Control Association may often have more credibility (and courage) than the government. In such contexts, the government relies on the NGO sector to take initiatives that may later jump-start government programs. For example, in the late 1980s the Natural Resources Defense Council took the initiative with the Soviet government in proposing and implementing new policies for US/USSR cooperation in monitoring nuclear tests, and participated in the implementation of these policies once thay had been accepted.

Still, when the government, particularly the Executive Branch, is offered advice that it does not want or like, even by NGOs of high lustre, the advice is likely to be pronounced dead-on-arrival.[16] If, to make matters worse, the NGO's input is found to be flawed or nonobjective, or if it is delivered confrontationally via the press or a media event, government is unlikely to trust the NGO next time. These caveats notwithstanding, NGOs have increasing opportunities to make their points effectively as government considers its courses of action.

This is true in part because government itself is not monolithic. Different agencies often connect to diverse and divergent NGOs. And the courts and Congress offer alternate routes of influence for NGOs frustrated by the behavior of Executive Branch agencies. Moreover, NGOs out to effect change can do so by stirring up their particular publics if the agencies appear somnolent, and the media often rouses Congress, too.

Figure 2. Testimony before the Joint Economic Committee of the Congress, Vice Chair Lee H. Hamilton. Edward L. Hudgins of the Heritage Foundation and Walter H. Plosila of the Suburban Maryland Technology Council discussed the report of the Carnegie Commission's Task Force on Science, Technology, and the States, presented by Richard Celeste, at a hearing on September 30, 1992.

Congress is particularly receptive to initiatives and positions taken by groups of citizens embodied in NGOs. Indeed, congressional hearings offer a multifaceted opportunity to pass information to those who want and need it (Figure 2). If an NGO expert testifies before a congressional committee, there is a chance for a personal exchange with the most interested policymakers, because members of Congress attend the hearings that matter most to them. If members of Congress do not choose to or cannot be present in person, they will be represented by staff, who will not only report to the members but will also include the information in communications with constituents who have an interest in the subject.

In turn, a significant subject will attract the media to a congressional hearing, and the expert witness may receive wide coverage in print or by broadcast, if the testimony is newsworthy. Transcripts of testimony are printed by the Government Printing Office and become a permanent record and source of information for academia, business, foreign governments, and many others. A sampling of congressional oversight and legislative hearings reveals the ubiquitous presence of representatives of NGOs at the witness tables. It is less clear that the full range of NGO competence works its way into testimony; all too often, the usual suspects are rounded up, while other promising witnesses are overlooked.

But the congressional relationships of NGOs also involve more than formal testimony. NGO experts slip in and out of side doors, sometimes leaving few traces, at other times a stack of documentation. Most contacts of scientists and engineers under NGO auspices with congressional staff members (and agency officials as well) are probably informal, taking place by phone, fax, at a conference coffee break, or at one of the numerous events of the Washington S&T circuit. The extent of such interaction is hard to assess, but it is surely considerable.

ON QUALITY

NGOs should not go lightly into policy research or policy advocacy. It is not for all NGOs, not even for those with a scientific or technological persuasion. Competence and consistency in high-quality research and studies, sustained over the years, are acquired at a cost. The learning curve, for an NGO feeling its way into service-to-government, will have its instructive surprises. After decades of intensive and varied work on behalf of government, RAND spells out what it believes keeps government coming back for more:

> a stubborn independence; a devotion to scientific inquiry, letting the chips fall where they may; an empirical, multidisciplinary, pyramidal approach to problem solving, where the policy analysis itself rests upon, and draws from a wide base of technical analysis and disciplinary skills; a penchant for 'thinking out front'—helping our sponsors define their future policy agendas so that the research can be started in a timely fashion; a strict avoidance of proprietary work; an insistence upon research of the highest possible quality, maintained through peer and editorial review; and a history of distributing publications broadly."[17]

It is difficult not only to attain high quality in policy work but also to sustain it, particularly as financial dependency on principal supporters may grow. It is all too easy to begin to sacrifice objectivity for a comfortable relationship with a sponsor.

■ *The Task Force impresses upon NGOs the sensitivity of the public policy process to the appearance of self-interest or organizational bias in their policy research and technical advice to government. It calls upon NGOs working on policy issues to apply unrelenting rigor to the quality and validity of their arguments presented in studies, reports, and testimony.*

It is important to recognize that potentially powerful sources of bias extend well beyond narrowly defined conflict-of-interest—an undisclosed personal economic interest in a particular policy outcome—on which media and the public often focus. The NRC has attempted to deal with bias by asking potential committee members to disclose situations in which they have taken strong and visible public positions on issues related to the subject of a committee's deliberations. Many qualified experts will have such bias, but the NRC tries to ensure that its committees are balanced and that all members are fully informed of other members' potential biases and are open about their own.

ON GOVERNANCE

Our observations on NGOs repeatedly emphasize accountability as the hallmark of organizations that sustainably and effectively address governments and influence outcomes. In turn, accountability comes close to summing up the core role of governance in this context. Though it is but one in a family of governance roles, it stands out in signaling sensibility for the implied co-responsibility an NGO accepts when it crosses from the sanctuary of the independent sector and into the chancier zone of the public sector. If co-responsibility is too much for an NGO to digest as a facet of its accountability, much of the force of the Commission's thesis on the centrality that science has in strategic policy management is diminished, and much of what the Task Force has said about the added value brought by NGOs to government may have to be discounted.

Against that background, the Task Force in its recommendations later in this report will come down strongly on the need for NGO governing bodies to reassess their roles, missions, and behaviors relative to the government relationship. Accountability enters into process no less than into substance. Equally, it is involved in the choice of means as well as ends, in the formulation of NGO objectives and goals, into conscious balancing of objectivity with advocacy, and certainly in watchfulness for abuses in science and the appearance of conflicts of interest.

There is, of course, more. Apart from the expectations associated with organizational accountability, the roles of governance run to interpretation of the NGO's missions and evaluation of how its agenda and its opportunities match the mission statement as well as the disposition of resources. For the governing bodies of many NGOs, such a menu can stretch capabilities quite far indeed. It is important to recognize that many NGOs are

structured in such a way that serious leadership problems arise. Often the leadership positions are bestowed to fulfill honorific objectives or other purposes besides interest in public policy, and the positions are rotated so that individuals serve on boards for only two or three years. Thus, it is difficult to ensure the continuity that favors quality control and continuous improvement of organizational practices.

The point to be repeated is the responsibility of the governance structures of NGOs for seeing to their scientific integrity and quality control. There is a danger for some NGOs that they may become captive to their staffs, who may have their own agendas or may become more interested in self-perpetuation than in furthering the public interest. The people who volunteer for governing the organizations are perhaps the only ones who do not have a potential conflict of interest between perpetuating their positions and furthering the original public interest of the organization. Yet active volunteer members of S&T NGOs, including board members, can also be naive about the policy process. Their knowledge is often brought to bear effectively only by the growing class of highly professional permanent staff members.

Governance responsibility thus means more than just lending one's name and keeping a benevolent eye on the activities of the staff; it entails continuous familiarity with what is going on intellectually as well as mutual education. This consideration applies equally to advocacy organizations, where both board and staff may have incentives to exaggerate and sensationalize scientific findings to attract members and funds, and to less partisan organizations, which may be tempted to go out to sponsors for grants or contracts of a "make-work" nature or that duplicate work of other groups. As NGOs proliferate, familiarization with the efforts of other NGOs working in similar fields becomes a serious burden, especially for part-timers.

At both ends of the spectrum, the question arises of how far the public can rely on self-regulation, competition in the marketplace of ideas, and the pressures of resource constraints. Privileges and protection come with 501(c)(3) status, but this is established rather informally by IRS regulation, with little public scrutiny.[18] In times of political polarization or scarce resources, the protection may become less secure. Governors of all NGOs and their associations, such as Independent Sector, need to worry about this in terms of defending NGOs from political attack and by making as certain as possible that activities of a few NGOs do not provide the excuses for a more general attack on all NGOs. One possibility is roundabout hostility by political forces in the guise of concerns about administrative propriety or accounting correctness. The present plight of the research univer-

sities in relation to indirect costs may offer an important lesson for NGOs. S&T NGOs cannot expect to be exempt from trends that may sweep the larger NGO world.

Governance and Government

It is with regard to government relations that governance takes on a larger significance. This is the level at which the decision is taken as to whether, when, and how the NGO should inject its resources, its good name, and its voice into issues and choices confronting political executives and legislators. How much exposure fits in with established purposes, objectives, and priorities? Would a drift to politicization follow, and where is the line to be drawn? Will the seductive nature of policy advocacy turn the head of the NGO and distance it from the support of its constituency? Once in the kitchen, can the NGO take the heat? Is there enough patience to work through a learning curve for confidence-building? Would it be wise to understudy a more experienced NGO before getting in too deeply?

There are other questions, too. Is policy advocacy likely to muddle the organization's standing with the scientific and technical communities, or bring a needed shot of vitality that promises a future? Should the NGO let itself be coopted into endorsing positions of other NGOs that it did not help to formulate, or should it keep its options open? Is there some principle of solidarity that argues for mutual security when facing criticism that is in some measure justified? Can NGOs straddle the double standard, practicing objectivity in technical advice but motivated by self-interest on matters close to home?

Once into the fray for better or worse, governance has to focus on the rules and standards of practice. It cannot settle for the kind of *ad hoc* oversight and after-the-fact corrections that tend to go with part-time governance arrangements. Serving up technical advice to legislators and regulators who are confronted unhappily with conflicting information and economic complexity calls for internal safeguards and measures that give the governing body reason for confidence in the quality of the analysis that goes out under the NGO's logo. Off-the-wall inputs leave ephemeral trails of accountability even when they are well-meant responses to situational pressures that are difficult to resist when a bill or an appropriations markup is at a critical stage.

Procedures for Quality and Accountability

What procedures are available to maintain quality and accountability? In instances familiar to the Task Force, NGO governance practice may turn

for help to such auxiliary supports as visiting committees, consultants, senior fellows in residence, self-studies, membership surveys or referenda, feedback schemes, or structured strategic planning exercises. If these aids are to pay dividends, the burden on governance is to articulate their questions and concerns clearly and coherently and then get out of the way. Outcomes can take the form of constitutional and bylaw changes, new activity starts, new links with affinity organizations, testing additional revenue streams, achieving different balance in funding, electoral reforms, reorganization of governance, program reorientation, new services for members, and improved budgeting, information, and long-range planning systems. The judgment call to be made by governance is when and how to invoke auxiliary support, and in which of the several forms. On the available evidence, some NGOs have left it until too late, while others have gained significant improvements in organizational planning.

Quality assurance arrangements are used widely by scientific and technical NGOs, although the mechanics vary. NGOs can learn much from each other by comparing the effectiveness of differing practices. What suits the needs of the National Research Council, with its high-volume docket of government studies, would look incongruous to a small NGO like the Council on Competitiveness, with its $1 million budget and staff of 10; yet each in its particular situation has the same generic accountability to funding sources and audiences. In the NRC the quality assurance function is centralized in a Report Review Committee with authority to prevent the release of a report until it complies with exacting criteria, while the Council on Competitiveness relies on its governing body together with the expertise built into its advisory committees. Although complaints from government staffers that peer review practices "take forever" to get out a report are standard fare, it is hard to see how an organization such as the NRC could sustain its reputation for authority and accountability by a less cumbersome process. By nature of the structure of the NRC and other organizations relying on similar procedures, the work must be conducted largely by volunteers who are extremely busy with other responsibilities. Still, the awareness that NGOs are serious about quality goes some distance toward explaining the steep and steady rise in government's calls on them for objective help.

Form of Governance—Costs and Effects

How elaborate or streamlined an NGO's governance scheme needs to be is one more variable in the multiform universe of the NGOs. Though inherently different kinds of organizations for science and technology, AAAS and the National Research Council both have elaborate governance struc-

tures, the former highly oriented toward electoral intricacy, the latter toward what is expected of the special relationship with government. Both, incidentally, have budgetary costs. AAAS reports that governance costs run about $4 million in a budget of nearly $40 million, a noteworthy cost factor if compared with $9 million covering its array of program activities for science education, international activities, and science policy. Still, the measure of governance performance is not how much money goes into it. Rather, it has to be judged by how well it works to drive organizational missions, while contributing significantly to government's ability to absorb science and technology into the making and management of public policy.

ON INDIVIDUALS AS VECTORS

In addressing the roles of NGOs vis-à-vis government, we tend to emphasize the printed reports prepared by these groups. What may be lost sight of is the interplay of human resources—people, their skills, their talents, their networks, their cultures. Government's research, development, budgeting, and legislating operations are carried out not with black boxes into which programs are inserted but by individuals from all sorts of backgrounds. The government employs some 200,000 scientists, engineers, and physicians.[19] They sit everywhere, from weather and agricultural experiment stations to the White House and the Capitol. They may be recruited directly for a lifetime career, borrowed from academia or industry to serve a few years or a few days each year, or drafted for presidential appointments. Most if not all belong to nongovernmental organizations, and many serve as officers in NGOs. (In 1991 the Office of Government Ethics questioned this practice but retreated from making a rule forbidding it in the face of extensive adverse comment.)

The federal establishment, and not only its scientists and engineers, is in continuous communication with the larger technical community through the mechanisms of NGOs. The studies and reports from the National Research Council each year carry the analytic inputs of some 7,000 individuals tapped for their expertise. There is a massive infusion and diffusion of knowledge through NGOs. The relationships and processes, though often structured around report writing and other formal activities, rather than the reports themselves, may be the main channels of NGO influence.

In fact, the reports that are the most visible symbols of the policy process are written only in part to be read. In great measure, the writing is undertaken to improve the rigor of thought, to form collective views, and

to establish the legitimacy and authority of expertise. Communication of information continues to be largely oral, especially at high levels in an organization.[20] U.S. executives spend only about 10 percent of their work time reading; most of the rest of their time is spent in face-to-face meetings and on the phone.[21] Members of Congress rarely have time to read more than a one-page executive summary, a brief memo, or the front page of a newspaper.

FELLOWSHIP PROGRAMS

The engagement of individuals in the policymaking machinery of government has come to be recognized in several programs. A prominent example is the intersociety science and technology fellowship programs managed by the AAAS for twenty affiliated organizations, the best known being the Congressional Fellows Program, now in its twentieth year.[22] Together, the fellowship programs have an alumni body numbering well over 500—Congressional, Diplomacy, Executive Branch, Arms Control, and Environmental Fellows. Through a carefully managed national competitive fellowship process, about fifty individuals make the cut each year, go through a multistage orientation, and are turned loose to find appropriate niches with Congress or other units of government (see Figure 3).[23]

The Fellows plunge into the whirl of the legislative system, helping with the technical details of bill-writing and committee reporting, preparing Members for hearings and speeches, and doing some research. A partial list of reported expertise shows an extraordinary range of skills and contacts funneled into the policy system: biochemistry, engine design, catalysis, tropical ecology, risk assessment, manufacturing, clinical research, Russian technology, astrophysics, global change, telecommunications, family violence, family poverty, game theory, pediatrics, wetlands ecology, nutrition, trademark law, lasers, reproductive biology, microbiology, hazardous waste management, and fertility regulation.

The congressional offices and committees actively seek these Fellows, and the demand always exceeds supply, now about 20 per year (of the 50 or so total Fellows). Still, Congress has shied away from bearing or even sharing the financial cost, which is borne by the sponsoring society and the Fellow. Like all budgets, those of NGOs are subject to competing demands, and each year the governing boards must decide whether they can continue to finance this program. If the congressional offices and committees were to meet at least some of the costs, the likelihood of NGOs being able to field more Fellows should increase.

Figure 3. 1992–93 class of Congressional, Diplomatic, and Executive Fellows. (Photograph courtesy of the AAAS.)

■ *We urge strongly that Congress find a way to (a) cost-share this program and (b) help at least to double the number of Fellows over the coming five years without in any way compromising the independence of the selection process.*

Experience with the S&T Fellows Program in the Congress and the Executive Branch has now accumulated to the point where an overall evaluation should be undertaken with an eye toward future directions. The Carnegie Commission has already encouraged the AAAS to review the achievements of the S&T Fellows Program and identify areas for possible growth and new ways to draw on the collective experience of the Fellows who have served. For example, it may be possible to extend the program to the states and perhaps the Judiciary. Also, periodic meetings and networking of the alumni may prove useful in improving the program and creating new opportunities.

TECHNICAL DEFICIENCIES WITHIN NGOS

Although many NGOs represent the scientific and technical community and many more address science-rich problems such as environment and health, the *resident* technical expertise of NGOs themselves is often deficient. Especially in their Washington offices, NGOs employ numerous lawyers and other professionals, but few scientists and engineers. Sometimes where scientific viewpoints are available, they are not respected or are turned only to narrow advocacy.

■ *The effectiveness, accuracy, and credibility of NGOs in many fields could be enhanced if they augment their own technical cadre and respect their findings.*

As NGOs in fields such as environment enter increasingly into technical disputes, the need to supplement their staffs of lawyers and policy analysts with technically trained experts has become apparent. The physical presence of these individuals would not only increase the analytic capabilities of the NGOs, but would also enhance the ability to communicate in a political system that relies largely on oral communication.

The National Academy complex offers the potential for a greatly enhanced presence of the nation's most distinguished scientists and engineers in our capital. Although about a third of the elected members of the NAS, NAE, and IOM participate each year in the advisory activities of the complex, rarely are the elected members in residence at the Academy for sustained periods.

■ *To increase the effectiveness of its advisory activities, the National Academy complex should enable 8 to 10 of its members to be in residence each year at the Academy in Washington as Senior Fellows.*

PRIVATE FOUNDATIONS AND NGOS

Throughout this report, mention is made of the involvement of private foundations as funders for NGO initiatives. This is an important relationship that goes a long way to explain and account for the striking breadth and vitality that shows up in the agendas of the NGOs. There is no question but that foundations, themselves NGOs, have made it possible for scientific and technical NGOs to do more than watch from the sidelines as technical

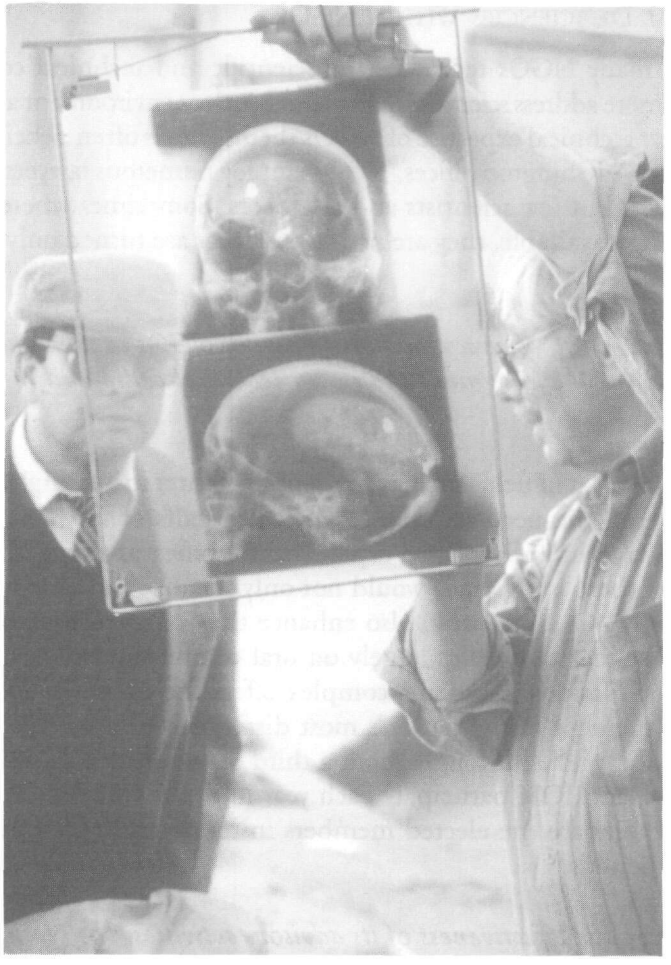


Figure 4. Pathologist Clyde Snow and a Guatemalan judge, Roberto Lemus Garcia, examine X-rays of a skull with bullet fragments exhumed from an unmarked grave at San Antonio Sinaché, Quiché. Dr. Snow represented Physicians for Human Rights, a Boston-based NGO. (Photograph courtesy of Physicians for Human Rights.)

and ethical dilemmas intrude upon the formation of public policy. Were it not for foundation generosity and well-grounded concern, NGOs would not be where they are today as active and productive enterprises in the fields of education, human rights (see Figure 4), arms control, national security, child and adolescent development, health care, environmental analysis and advocacy, and policy research.

Granting all of the above, foundations could play an even larger part in encouraging qualified NGOs to engage in societal issues and dilemmas

that they can address with competence and balance. As one former foundation president puts it,

> Not being creatures of the moment . . . foundations are able to take the long view. . . . [T]heir independence gives them an opportunity, and responsibility, to look farther down the road, to recognize that they have opportunities different from those of government. . . . [T]hey can support what is important but currently out of favor. They can step in where something is politically untouchable. . . .[24]

Science and technology are the essence of a long view; more foundations can operate serious programs sensitive to the potential of science and technology than do so now.

Money is not all that foundations provide. The American experience is that they are likely to be the first nongovernmental organizations to anticipate and define societal dilemmas and sketch architectures of research, analysis, and future advocacy to which they are ready to pledge resources. Through these processes the foundations can call up the critical (and sometimes quarrelsome) mass of thought and systematic treatment that leads to focusing attention and debate, opening minds, and creating space for societal experiment and change.

Important as foundation funding is to scientific and technical NGOs, it is not unlimited in availability. Foundations, like the NGOs, face more opportunities than they can meet. Large foundations are structuring their support strategies in multiyear terms and program aggregates, and there is evidence that at least some NGOs are consciously repositioning their agendas and goals in strategic terms, taking into account, among other considerations, the intentions, expectations, and priorities of funders. Indeed, scientific and technical NGOs might do well to strengthen their presentations to granting organizations by demonstrating that they practice interorganizational coordination in their multiyear development planning, thereby minimizing redundancy and proposal costs, which can be large elements in overhead.

POLITICIZATION

Undeniably, scientific and technical NGOs at times practice advanced methods of pressure-group politics in the pursuit of their perception of beneficial outcomes, sometimes overtly and sometimes by indirection, despite strictures aimed at limiting lobbying activities.[25] In the runup to recent presidential contests, NGOs actively pressed major candidates and platform com-

mittees for assurances of support for the research enterprise, with satisfying results.

Congressional leaders and administrative executives, for that matter, have openly criticized the scientific, technical, and academic communities for their political passivity and naiveté. They warn that competitive politics will leave these communities behind unless they equip themselves to fight strenuously for their legitimate interests.

One result is the growth in the number of NGOs that maintain Washington offices for tracking, monitoring, reporting, and fast response. Another result is the employing of former members of Congress as NGO advocates and the hiring of lobbying firms to get results that are to the advantage of particular NGOs, even at the expense of the wider needs of the research enterprise. To the extent that such survival strategies succeed and are emulated, the scientific and technological enterprise invites conflicts with competing and more experienced pressure lobbies while risking substantial damage to its long-standing apolitical image. Such activities may put the enterprise into a bind from which it may be unable to extricate itself. It is in part for this reason that a separate Commission task force offers proposals for new policy machinery for linking long-term societal goals with long-range programs in science and technology.[26]

A key element in politicization is the media. How various NGOs use and misuse the media to further their objectives; how the members of the media interfere with, shape, and mediate the S&T agenda; and how the media themselves become the focus for public discourse beside and beyond the forums on which they report—all these complicate any idea of simple interplay between the advisers and the advised. Indeed, many NGOs can now hardly do without the media to reinforce their points of view or air their findings.

The Commission has argued that it is desirable for more scientists and engineers, individually and collectively, to become actively involved in science and technology policy activities and public affairs.[27] This Task Force report provides some of the principles that must underlie increased engagement.

HOW MUCH PLURALISM?

"System overload" in the United States is a price exacted by an excess of pluralism.[28] A profusion of disparate NGOs, including those in the scientific and technological arenas, similarly points toward chaos and gridlock

by crowding the circuits of communication with government. The remedies are anything but obvious as the independent sector unremittingly expands the galaxy of voluntary organizations under the banner of pluralism. In a very real sense, the capacities of this greatly differentiated and variously motivated sector serve to energize the effectiveness of checks-and-balances politics, yet leave us to cope with its side-effects and contradictions.

When the structural anomalies of science's institutions get in the way of coherent expressions of consensus on ends and means, it is not the fault of government. Indeed, the belief that a large increase of general research funds is the magic bullet to put everything right is itself an obstacle to facing up to the implications of system overload. It does not wash to criticize government for an inability to make up its mind, when the scientific and technical fraternity itself owns up to confusions. Pluralism is a defining characteristic of an open society, with virtues and faults alike. Unchecked by consensus standards of responsibility in issue advocacy, in the practice of politics, and in the quality and validity of reports, testimony, and internal position papers, and informal as well as formal advice to government, pluralism can encumber the democratic process rather than facilitate it.

2

MOVING ON

THE 1990S: A TIME FOR REEVALUATION

Much has altered in the American discovery enterprise in science and technology: how it is formed and supported; its bearing upon national security and environmental sustainability; its resonance with ethical and moral dilemmas; its expectations to lead the world in all fields; its assumptions relative to levels of government support and investment; the quality of the academic infrastructure; and its centrality to strategies for national competitiveness in a changing world economic order. In all these altered dimensions policy choices will not come easily, and seldom will they come coherently. The opportunities for nongovernmental organizations to contribute to constructive outcomes is significant. But opportunity alone is not sufficient: capacity and excellence in delivery must go along with it. Leadership, resources, processes for quality reliability, and membership support are among the necessary ingredients.

The Task Force's primary recommendation is that, given the rapid growth of NGOs and the new confluence of pressures,

■ It is urgent for S&T NGOs to review their missions, priorities, and goals and to assess their performance in light of their objectives with respect to government.

Among the questions NGOs must ask are whether rigorous processes are in place to ensure the excellence and reliability of their work; whether conclusions and recommendations are reaching the right ears and audiences; and whether these recommendations are formulated in such manner as to be genuinely useful.

As scientific and technical NGOs expand, diversify, look beyond parochial concerns, and acquire new sources of support, they should seek to reaffirm that they

- Seek progress in science and innovation within the frameworks of human values and social responsibility
- Maintain vigilance for their independence and freedom to act
- Use the talents of their members effectively, given the importance of volunteerism in American society and particularly the demonstrable readiness of scientists and engineers to respond when given the opportunity
- Work as responsible democratic institutions at the sensitive interfaces of science and technology with government, whether at the level of the Executive Branch, Congress, the Judiciary, international organizations, or state and local government
- Seriously and attentively manage changes in the terms on which they relate to governments
- Consistently examine and use operational guidelines with respect to revealing sources of bias in their advisory work and use appropriate means to balance or make clear these biases to government and others concerned
- Balance organizational identity and autonomy with arrangements for interorganizational networking and cooperation with a view to minimizing wasteful overlap and conflict while maximizing productive interchanges
- Make certain that efforts to address far-reaching, long-range opportunities and social expectations at home and in the world are not overcome or displaced by near-term strains and systemic stresses

There is no court in which to sue for malpractice when it comes to the question of S&T advice to government. Most of the accountability for the fair use of scientific fact must necessarily be internal to organizations that engage in science advising. Thus arises the importance of the track record

of NGOs and the transparency of the process they use to reach conclusions. The Task Force believes that there will be family resemblances among those NGOs with whom government should speak most seriously on matters of science and technology, and that the resemblances will arise from thoughtful organizational policies and procedures addressing the challenges outlined above.

IMPROVING POLICY STUDIES

As NGOs engage in dialogues over governmental goals and priority choices, it becomes apparent that thoughtful policymakers increasingly reach for intelligible and credible syntheses of research related to important policy questions. Pertinent information tends to be widely scattered. It is also difficult for the nonexperts to assess the credibility of assertions on emotionally charged issues. Analytical rather than polemical approaches are needed where urgent and complex issues are at stake. Jumping to conclusions or using a heavy ideological filter can lead to major mistakes.

The Task Force sees a signal role for NGOs in informing the government and the attentive public by providing the best possible analysis and advice on long-term questions of critical national importance, including raising early warning signals on emerging problems and identifying neglected opportunities. As an area of scholarship, however, the policy research community resembles a cottage industry: unevenly supported, frequently isolated, and experiencing formidable barriers to growth and impact.

As with most such matters of institutions and their behaviors in the open market of policy opinion and action, the profile of NGOs in the arena of science, technology, and public policy turns out to be ambiguous. It is a mixture of striking and demonstrable strengths balanced by structural confusions and polarities. Centers of high reputation for proficiency are not lacking but are relatively few, considering the scale of science and technology and their centrality to the nation's business. Moreover, there is little evidence that policy studies today have consistently improved over those of 10 or 20 years ago, notwithstanding the arrival of new methods, hardware, and software.[29] If the NGO universe continues to grow and multiply while seeking to increase its influence in the ongoing search for workable policy outcomes, the prospect for objective and useful interaction with government will turn both on the performance of a selected cluster of organizations and on the systemwide arrangements for information-sharing, communication, continuous improvement, and accountability.

Interdisciplinary policy research is demanding and expensive, as

undertakings by RAND, the National Research Council, and the Office of Technology Assessment demonstrate time and again. Studies frequently cost half a million dollars or more. Universities cannot afford sponsorship of such work on a continuing basis without grant and contract support.[30] For most scientific and technical NGOs, policy studies are financed on a shoestring, or the costs are shouldered through intersociety sharing. Even with these handicaps, the quality of the work commands worldwide notice and kudos. But, there is little evidence that the existing incentives and opportunities will attract young men and women to take chances on careers in policy scholarship in significant numbers absent more favorable academic conditions and a greater willingness on the part of major public and private foundations to make long-term commitments to the growth of the field. One difficulty within universities is finding tenure-track support for the kind of work discussed in this report. Although it is possible to conduct policy studies within a political science or government department, it is nearly impossible within a science or engineering department, and thus many of those most qualified to perform the studies are directed away from them.

The Need for Leadership

Leadership is needed to inform, cohere, and support the field of policy research in science and technology. As the Carnegie Commission has noted generally, the rapid and pervasive transformation resulting from science and technology calls for strengthening of institutional capability for scholarly analysis of critical issues based on a broad foundation of knowledge and experience and for imaginative, credible, realistic policy design.

Because of its requirements and resources, the government of the United States is in an extraordinarily strong position over the long term to stimulate and support productive inquiries at a level far beyond what it is doing now. The nation must capitalize on the extraordinary capability of its diverse nongovernmental institutions to get the best possible analysis, advice, and design on long-term questions of great national importance.

■ **The Task Force recommends that the National Science Foundation, working with leading governmental users and practitioners of policy analysis, such as the Congressional Office of Technology Assessment, join with private foundations, and other potential supporters of policy research and analysis, to help define the research agenda in this field, agree on how it will be supported, and promote arrangements, in both NGOs and universities, to encourage the cumulative learning that can help advance the craft of policy analysis and design.**

There is a need to find better ways to support independent policy studies by NGOs, and equally important is the support for fundamental research on methods.

University-based policy studies in science and technology provide a vital part of the base on which NGOs draw. There are perhaps 30 university groups that seriously pursue such efforts; almost all of their studies are weakly supported, and none of the groups has core financial stability. The tradition of stiff internal criticism in universities is particularly important, because many emerging NGOs lack such a tradition. Providing stable funding to perhaps 5 or 10 of the university groups for serious, *long-term* policy research could greatly strengthen the culture of this field and accordingly the whole NGO scene in science and technology. At the same time, many NGOs have been far more successful than universities at the organization of transdisciplinary work, and universities may learn from NGOs in this regard.

Information Network—A New Life for Neglected Reports

A related concern is the semi-orphan status of finished policy studies, reports, and commentaries. OTA and the NRC can flourish blockbuster products at press briefings and hearings, while first-rate studies from the hinterland may get little or merely passing notice. As NGOs seek increasingly to advise on problems of choice, they would benefit considerably from information on where related policy research is under way, who the principals are, and what completed reports are available. *If* Science *magazine, for example, were to increase its efforts to provide periodic annotated listings of completed science and technology studies and reports, the beginnings of an information network could be put in place as a step toward bringing the policy research community together.*

At the same time, such a network would supply capital to the knowledge base of the NGOs as they prepare positions for government's consideration. Equally, NGOs of the scale and broad interests represented by AAAS would furnish a positive service to science and technology policy studies if they would systematically operate electronic bulletin boards listing the stream of studies, position papers, and reports in process and emerging from the Office of Science and Technology Policy, the Council of Economic Advisers, the Office of Technology Assessment, the Congressional Budget Office, the General Accounting Office, the Congressional Research Service, the National Research Council, the Council on Competitiveness, academic policy research groups, foundations, and think tanks. Such information services could go some distance toward bringing together the diffuse strands of policy

research and, in time, could mitigate in some measure the duplications and confusions attending pluralism.

NGOs AND CONGRESS

On government's side, the new Congressional Science and Technology Study Conference and Institute, recommended by the Commission's Committee on Science, Technology, and Congress, would go far to close the loop between NGO analyses and the deliberative process in Congress.[31]

THE NATIONAL ACADEMY COMPLEX: MAINTAINING LEADERSHIP

The Task Force takes note of the public service rendered over many years to government by the National Academy complex, striking in its range, scope, and versatility, and symbolic of the entire American enterprise in S&T and of the NGO universe in S&T. The unique role of the Academy complex reflects the charter granted to the NAS in 1863 by the U.S. Congress, which engages the Academy "[W]henever called upon by any department of the Government, [to] investigate, examine, experiment, and report upon any subject of science or art."

CAREFUL GROWTH

As government recognizes the quality and value of Academy studies and reports, its calls upon the Academy complex tend to tax severely its capacity to respond. The Task Force commends the Academy complex for its record of remarkable advisory services to government in areas of science and technology bearing upon the policymaking process, while expressing a measure of concern lest the burgeoning demands on the complex work to the detriment of its unique capacities. There are few if any further economies of scale to be realized in the conduct of the kinds of studies for which the Academy is most valued; each effort is customized, and beyond a certain point a larger number of studies does not bring obvious opportunities for efficiency.

■ **The Task Force, while it views the overall record of the Academy complex as exemplary, urges the Academy's leadership to audit carefully the**

continuing balance of its work program and to consider ways an expanding work program can be carried out with traditional vigilance and attention to the integrity of procedures.

The concept mentioned earlier of having in residence a group of eight to ten members of the NAS, NAE, or IOM would help extend the oversight capabilities of the management structure of the Academy complex.[32] They might have the time and opportunity to give reflective thinking to the purposes, goals, and relevant procedures of the totality of the portfolio and, equally important, potential portfolio and how it might be implemented.

Applicability of Academy Policies, Procedures, and Experience

The policies, procedures, and experiences of the Academy complex are of significance not only within the Academy itself. They are a point of reference for other NGOs engaged in advising government on S&T issues, for the growing number of academies elsewhere assuming comparable duties within their own countries and at the state level within the United States, and for providing the advice of the international scientific community to intergovernmental organizations. *The procedures that the Academy complex uses might be published in a readable form that would be useful to other NGOs involved in providing collective S&T advice.*

Such a publication might also prove useful in providing guidelines that would be more easily followed by the panels and staff of the Academy complex, particularly as it expands and assumes new duties. Among the topics that might be covered would be the creation of competent, fair, and balanced panels; roles and responsibilities of chairs, panel members, and professional staff members; recognition of sources of bias and conflict of interest; formal review procedures; the seeking of consensus and the handling of dissent. Such topics have been touched upon in Academy publications, but not in accessible form widely available to others.[33]

Financial Resources

The heavy financial dependence of the Academy complex on numerous individual contracts with agencies of the federal government for particular studies has advantages and disadvantages. Although the structure helps assure responsiveness, overdependence puts the professional staff members of the

Academy complex in an actively entrepreneurial mode of operation. A balance needs to be struck.

■ **To assist in balancing short- and long-run pressures, the Task Force recommends the charging of an appropriate fee for the services of the Academy complex.**

This fee would be comparable to the fee some other nonprofit corporations charge government or to the independent research and development (IR&D) expense allowable in certain kinds of government contracts. The fee would enable the Academy to increase its reserves available, or working capital, to meet expenses incurred for the government associated with unexpected testimony or dissemination activities, studies required on very short notice, and other legitimate unanticipated costs. *Such a surcharge should be carefully considered by the Congress.*

The Task Force also encourages the building up of the independent resources of the Academy complex to initiate and carry out studies of a very long-range or controversial nature. It may also be time for the Academy complex to look seriously with its government partners at more radical alternatives to its current funding paradigm of hundreds of small contracts.[34]

New Dimensions of Service

Several ways for the Academy complex to strengthen its capabilities to meet Congress's needs have been proposed by another Task Force of the Commission.[35] We echo them here. One need, as just implied, is for a means for timely provision of funds to the Academy complex, so that studies desired by Congress can be initiated in a matter of days rather than being delayed many months for funding. On the Academy's side, there is a need for its committees to prepare more highly concentrated summaries (1–2 pages) of reports, presenting information in a nontechnical, easily understood format. In addition to its authoritative formal reports, the Academy should also sponsor publications dedicated to open discourse on controversial topics, a mode more closely akin to publications in experimental science.

Other frontiers the Academy complex should explore are improved means to interact with state and local governments, the courts, and partners outside the United States. It will be increasingly desirable and necessary to carry out studies with scientists from outside the United States or jointly with counterpart institutions outside the United States and to have efficient, sound, agreed-upon mechanisms for doing so.

The Academy complex should explore the difficult problem of ways

of making comparative value assessments across disciplinary lines, even though its own professional community is structured along disciplinary lines. Even within disciplines, there is still structural difficulty with priority setting, as is seen in the disputes about megaprojects such as the Superconducting Supercollider.

Finally, the Academy complex should join with the Office of Technology Assessment and other groups in NGOs, universities, and the private sector in experimenting with the application of new methods for policy analysis and the use of advanced information technologies in conducting and communicating policy studies in science and technology.

The Academy complex is the most powerful single national asset outside government in formulating S&T policy, in assessing programs and policies, and in elevating the debate in the federal establishment, academe, the S&T community at large, and the general public. If it did not exist, something close to it would have to be invented. The growing number of organizations abroad emulating the roles and responsibilities of the Academy complex is testimony to the power of the idea and to how well it has been implemented. Enormous expectations flow from its past performance and unique status. It must be enabled to maintain its enviable leadership.

SUPPORT FOR STATE GOVERNMENTS

Consideration of NGO relationships with government tend to emphasize the needs of the federal government rather than the states. It needs no essay by the Task Force to spell out the mounting responsibilities of the states relative to education, risk assessment, health services and costs, crime and justice, economic and technological infrastructure, transportation, and regulatory and environmental dilemmas. As the federal government unloads duties onto the states, the dockets of the state legislatures are experiencing system overload, too, with bills and debates as well as oversight responsibilities that bring scientific, technical, and environmental-quality factors into play.

Although few states have the in-depth analytic resources found at the national level of government, state regulatory and judicial procedures affecting health, safety, and other sensitive responsibilities are increasingly subjected to interventions citing scientific and technical risks (often by advocacy-type NGOs). Economic development targets and employment strategies may hinge upon attracting or keeping advanced technology industries or establishing enterprise areas, upgrading the caliber of research and engineering universities, and competing for prized federally funded

centers for critical technologies. The long-standing convergence between government and science and technology on the national level is finding a match at the state level.[36]

Evidence of scientific–technical NGO involvement with state governments is sketchy, while the array of pressing needs and opportunities to provide support is open-ended. Organizations of state officials such as the National Governors Association and the associations of state public administrators offer potentially fruitful points of communication for NGOs. The National Academy's Government–University–Industry Research Roundtable, through its Federal–State Dialogue on Science and Technology, offers a useful conferencing process for state officials to interact with federal agency officials in clarifying the substance and reach of national programs and policies and their impacts on state government problems. This is, to date, a modest initiative and one that only begins to suggest what the roles of NGOs might be in this context. Numerous groups that cut across the independent sector, government, and industry, such as Maryland's Montgomery County High Technology Council, have been forming to bring to bear the best thinking on fostering technological enterprises at the state and local level. These groups are networking nationally in groups such as the Association of Technology Business Councils.

The Science and Technology Compact of the States, proposed by the Carnegie Commission's Task Force on Science and Technology and the States, would provide an excellent structure through which state leaders could exchange views and form relationships with S&T NGOs. *Finding ways to wheel their capabilities into position to reinforce state governments constitutes an increasingly important part of the emerging agenda of the nongovernmental scientific–technical groups.*

Assistance to state governments need not hang on NGOs of mainstream status with large and deep organizational resources. Local or regional science-based environmental research organizations with an affinity for grassroots, low-profile research rather than Page One headlines, can be effective in sorting out complex problems with state bodies. One such NGO is INFORM, a small environmental research NGO that does not lobby or litigate. Its role as a catalyst for advancing new methods for source reduction of industrial wastes has drawn commendations from state authorities and industries alike. Decidedly independent, this NGO works with government, business, and environmental groups but accepts no government or corporate contracts, relying instead on foundation, individual, and corporate contributions to sustain its activities. Would state governments be as well served were small organizations like this assimilated into larger, multipurpose NGOs? The answer is not obvious, but the suspicion is that it would be a case of fixing something that is far from broken, where local capacities may better

serve. Among the S&T NGOs most useful to states may be those affiliated with local universities and able to form partnerships with both government and industry.

Finally, many states have academies of sciences, engineering, and medicine. These have usually emphasized their honorific roles and their functions in improving communications within the community of scholars. Examples of state organizations that have successfully taken on advisory roles include the California, Connecticut, and New York academies of sciences.

■ **The Task Force urges state academies to engage in dialogue with state governments about their needs for advice in science and technology and how academies might help meet these needs.**

The argument for meeting the states' needs may be extended in many cases to localities, including cities and counties. Mayors, city councilors, and county executives would in numerous circumstances benefit from the enhancement of the capacity for science advising by NGOs outlined here for the state level. The New York Academy of Sciences provides an example of an organization that has usefully played such a role at the metropolitan level.

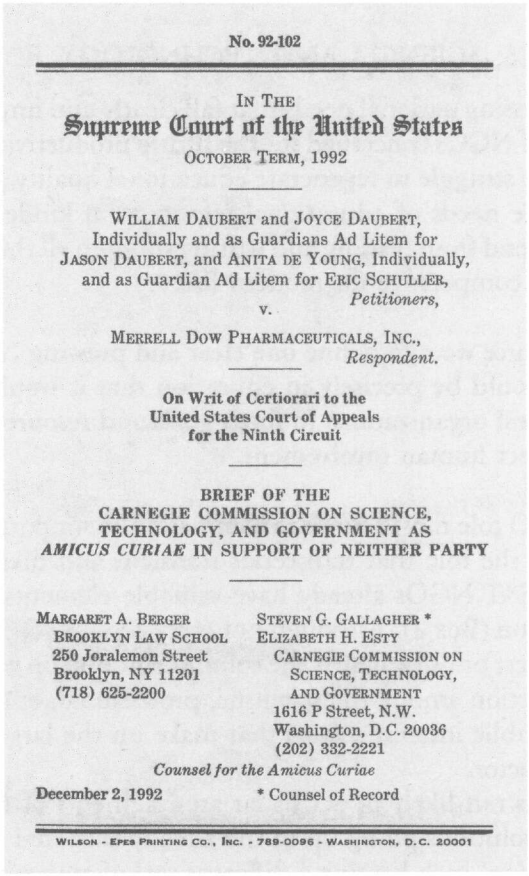
ASSISTING THE JUDICIARY

The Judiciary faces particular challenges in addressing scientific and technological issues because judges and juries often do not have great scientific or technical expertise. Moreover, the capacity of the courts to obtain external advice is constrained by the nature of the judicial decision process. Because many of the central issues of our society are resolved in the courts, including issues with significant scientific and technical content, there is a need to find appropriate means to assist the courts in reaching informed decisions on scientific and technical matters. A separate Carnegie Commission Task Force is reporting on this subject.

Some NGOs with an advocacy mission have long used the courts to further their purposes. This is particularly true in the environmental field, where advocacy NGOs such as the Environmental Defense Fund and the Natural Resources Defense Council have relied extensively on litigation to achieve their ends. Most NGOs, however, are not familiar participants in the work of the Judiciary. Yet, just as the executive and legislative branches benefit from scientific and technical advice that NGOs provide, so, too, the courts would benefit if advice were more readily available and if the judicial

system were better prepared to receive it. Increasingly, NGOs may discover that their missions are not fully satisfied if they do not participate in some fashion in the work of the judicial branch.

The means by which NGOs can assist the courts remain largely to be defined. Some may choose traditional advocacy roles, perhaps by submitting briefs in appropriate cases as a "friend of the court" (see Figure 5). Other more novel opportunities may also be available. For example, current law allows a judge to appoint an independent expert to assist in his or her deliberations; neutral NGOs might assist judges in identifying such experts. Similarly, professional scientific and engineering societies should explore



No. 92-102

IN THE
Supreme Court of the United States
OCTOBER TERM, 1992

WILLIAM DAUBERT and JOYCE DAUBERT, Individually and as Guardians Ad Litem for JASON DAUBERT, and ANITA DE YOUNG, Individually, and as Guardian Ad Litem for ERIC SCHULLER,
Petitioners,
v.
MERRELL DOW PHARMACEUTICALS, INC.,
Respondent.

On Writ of Certiorari to the United States Court of Appeals for the Ninth Circuit

BRIEF OF THE CARNEGIE COMMISSION ON SCIENCE, TECHNOLOGY, AND GOVERNMENT AS *AMICUS CURIAE* IN SUPPORT OF NEITHER PARTY

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December 2, 1992

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Figure 5. An *amicus curiae* brief filed with the Supreme Court by the Carnegie Commission on Science, Technology, and Government. The purpose of the brief was to "explain the process by which science is conducted and to suggest that the nature of the scientific enterprise requires rejection of current tests for the admissibility of expert testimony."

with the courts ways of verifying the credentials of experts and should offer guidance to their members as to appropriate professional behavior in the courtroom. It might also be possible to extend the network of "science and technology fellows" provided by the S&T professional societies to the Judiciary or to the institutions that support the Judiciary.

■ **The Task Force urges S&T NGOs and the legal community to focus their attention jointly on the opportunities and means for strengthening judicial decision making with respect to science and technology.**

MATHEMATICS, SCIENCE, AND TECHNOLOGY EDUCATION

Among the pressing national needs that fall clearly and imperatively within the bailiwick of NGOs concerned for the future productivity of science and technology, the struggle to regenerate educational quality and opportunity stands out. The needs of educational reform from kindergarten through high school extend from reading and writing through all the other essentials of educational competence for modern life.[37]

■ **If the Task Force were to define one clear and pressing NGO mission for the 1990s, it would be precisely in education that it would call upon the nongovernmental organizations to focus goals and resources—both of creativity and direct human involvement.**

This is the NGO role most certain to command the support of membership constituencies, the role that transcends transient and divisive issues.

Many S&T NGOs already have valuable elements in place in the field of education (Box 4). Although not every S&T NGO can or will assign education highest priority, here is the common ground on which to organize coalitions for action among the scientific, professional, engineering, pedagogical, and public interest sectors that make up the larger mosaic of the independent sector.

What is not likely to get us far are fragments of reform strategies and packaged solutions piling up in the already cluttered corridors of precollege instruction, each bearing a different seal of authority and advocacy. *The situation challenges the NGO system to come up with persuasive, concerted recommendations and models for experimentation and use, perhaps with cohering initiative by the National Academy complex and the major federative-type NGOs.*[38] The recommendations and models should address remedies for dissatisfactions with the state of the learning process, qualification

Box 4. Examples of NGO Programs to Improve Science and Mathematics Education

American Association for the Advancement of Science. Project 2061 (in recognition of the date of the return of Halley's Comet), a decade-long initiative to define desired outcomes of school education with regard to scientific, technological, and mathematical knowledge and skill, and to develop curricula to produce these outcomes.

National Science Teachers Association. Project Scope, Sequence and Coordination of Secondary School Science (SS&C) to restructure the traditional one-year blocks of life, earth, and physical sciences into a more integrated and coordinated program.

American Chemical Society. National review of chemistry education examining curriculum, recruiting, teacher training, and facilities, among other issues, summarized in *Education Policies for National Survival* (1989).

American Association of Physics Teachers. Physics Teaching Resource Agent Program (PTRA), sometimes called "teachers teaching teachers," to provide 3-week training institutes for precollege teachers in computer skills, innovative laboratory approaches, and other areas.

Mathematical Association of America. Strengthening Underrepresented Minority Mathematics Achievement (SUMMA) to attack the problem of underrepresentation at all levels, from kindergarten through graduate school, including teacher and faculty development.

American Statistical Association. Quantitative Literacy Project to train master teachers and develop curriculum and educational materials in statistics for secondary schools.

American Geological Institute. National Center for Earth Science Education (NCESE) to provide information about earth science education, to develop new kindergarten through 12th grade curriculum, and improve assessment of achievement.

American Meteorological Society. Program to develop innovative teaching of environmental sciences in secondary schools through studies of contemporary issues such as global warming.

New York Academy of Sciences. Research Training Program designed to educate middle and high school students in laboratory technique, qualities required for successful research, and how to write a research paper and make an oral presentation of research results.

of instructors, and testing and performance assessment requirements. At the least, mainline NGOs can, with encouragement from foundations, employ their convening skills effectively across the universe of organizations concerned with education. The resulting gatherings would facilitate sharing of experiences, strategies, and feedback from teachers, administrators, and parents as an illustration of what is involved in "common ground." This surely is not asking too much of NGOs.

A promising example is the Mathematical Sciences Education Board (MSEB), established at the National Research Council in 1985 to build a new "piece of the educational infrastructure" to look at issues of mathematics education more globally than could any one society. The MSEB reaches beyond the traditional boundaries and draws into the inner circle representatives of all the critical communities, including school boards, parents, business and industry, and chief state school officers. The MSEB was conceived by the 15 national mathematical societies with the understanding that the host institution had to stand outside the immediate mathematical community and be capable of dialogue with both governmental and scientific circles. The MSEB has become a significant voice and force for better mathematics education, working to establish State Mathematics Coalitions, at the national level to develop standards and curriculum, and as a mediator between the educational community and the multimillion-dollar testing industry.

An important challenge is to turn the disciplinary structure of many S&T NGOs to greatest advantage in encouraging educational reform. Although no single disciplinary society acting alone may be able to have a major impact, simultaneous, concerted action by several could be synergistic and much more powerful.

In short, the Task Force considers that NGOs have the opportunity—and the obligation—to lead action toward reorientation and reform in science, mathematics, and technology education with concerted strategies and provisions for evaluation.

PUBLIC AWARENESS AND THE RESPONSIBILITY OF SCIENTISTS

A second compelling mission for NGOs relates to increasing public awareness of the potentials and limits of science and technology in resolving intransigent dilemmas. The Task Force notes the lag between the rate at which science progresses and technological innovation races and the rate

at which information is disseminated and absorbed. Some of the technical problems here relate to translation, interpretation, and evaluation – but they are often overshadowed by human controversy and by institutional resistance or inadequacy. To the extent that progress and technical complexity outdistance the public's capacities for balancing benefits, costs, and tradeoffs, the outlook for positive policy outcomes is not promising. This is an area of opportunity and need that NGOs are strongly positioned to step up to, and it is decidedly in government's interests to encourage and assist NGOs in their efforts.

Misunderstanding, disinformation, and misinformation are no friends of science and technology and a hazard to public confidence and support. The barriers to a high level of public understanding are many and formidable, reaching from deficient education and scientific and technical illiteracy to chronic public anxiety fed by the battering impacts of unexplained fact, hypothesis, claim, counterclaim, and myth. The public gets most of its information from the news media, a portion from government, and some from corporate advertising and other sources. In its full dimensions, the task of raising public understanding to a level that approaches the pace of discovery and application looms so large as to appear beyond the resources of science by itself.

In the view of the Task Force, the main responsibility for delivering scientific and technical information understandably to the public should remain with the media. Over a long postwar period, print and broadcast media have developed impressive, but still inadequate, skills in technical reporting and analysis. The role most manageable for NGOs is to reinforce the capabilities present in the print and electronic media.

In fact, the NGOs are doing some impressive work in these directions, through the AAAS–Westinghouse Awards for outstanding science reporting and feature writing, the Media Science and Engineering Fellows Program of the AAAS, and the Op-Ed service of the National Academy complex. Of considerable impact are the outreach strategies of groups such as the Federation of American Scientists and the Worldwatch Institute, often prophetic and attention-grabbing. Deserving special note and support is the Media Resources Program, funded precariously by the Scientists Institute for Public Information, structured to help news reporters check their facts and stories with a large pool of volunteer scientists and engineers in time for news deadlines. Media treatment of scientific and technical issues under deadlines and severe rationing of on-air time is a challenge to accuracy and balance. The opportunity to help in getting it right the first time is an emergent challenge to S&T NGOs, and it should be reflected in the priorities they assign their roles and missions.

All such effort, to be sure, is premised upon the proposition that government and the public know the biases and interests of experts and have justified confidence that their behavior in interfacing with the political process is all that it should be. If scientific authority is used to mask a special interest or bias, if professional feuds are aired confusingly in public, if conflicts of interest surface repeatedly, if institutional coverups conceal misbehavior, if arrogance forestalls public accountability, if proposal pressure shades into practicing favoritism, or if whistle-blowing is met with retaliation, the index of trust can spiral down precipitously and the cost to the collective scientific and technological enterprise can be high.

■ **The Task Force underscores the set of problems associated with the responsibility of science to society as unfinished business and looks to one or more of the broadly representative NGOs such as AAAS or Sigma Xi to initiate a consensus paper on behavioral obligations of scientific and technical experts and organizations in interacting with the policy process.**[39]

With this for a start, the responsible representative organizations can begin to raise consciousness in the community about the role of expertise across the policy process and the accountability of each scientist for adherence to objectivity and acknowledgment of the limits of scientific and technological certainty. In the end, the process must stimulate better public understanding of science and better understanding of the public by scientists.

3
CONCLUDING REFLECTIONS

LIMITS TO GROWTH?

A look backward through the series of annual volumes of the *Encyclopedia of Associations*, a useful and revealing reference series, demonstrates the striking growth of the NGO movement as a whole and of the scientific, technical, and engineering subset with which this report deals. In large part, spurts of growth appear to be in response to the emergence of issue areas, a notable example being the rise of environmental consciousness in the 1960s and 1970s, which stimulated new policy centers and grassroots NGOs while jump-starting older organizations that had kept the faith during the years of low public awareness. Concern about loss of faith in individualism, entrepreneurship, and free markets led to a burst of growth of organizations such as the Hudson Institute, Hoover Institution, and the American Enterprise Institute and enhanced their ability to attract distinguished scholars. Technological advance also had a role in the expansion of the NGO universe,

resulting in sharp increases in the numbers and membership rolls of organizations concerned with the information sciences and communications technology. The stunning recent rate of scientific discovery in the biological sciences likewise had telling effects on the mix of NGOs. Growing concerns for the plight of underserved groups as well as the phenomenon of "science anxiety" brought other NGOs onto the crowded scene.

Not all these latter-day NGOs have prospered. Given the present sharp competition for scarce financial support and member recruitment, it is more likely than not that growth in the scientific and technical NGO sector faces a period of slowdown and even shakeout. The 1980s saw a drying-up of the earlier government largesse that had provided steady nutrition to policy research organizations, including NGOs. Major foundations could respond to only a fraction of the tidal wave of proposals that inundated them. Indeed, foundations in a position to help launch a particular NGO in a desired direction found themselves obliged to cap the periods of assured support in order to maintain flexibility to address their other goals and purposes.

Constrained fiscal capacity on the part of government tells only some of the story: a generic distrust of policy research and independent studies carried out by the nongovernmental sector seized parts of the government in the early 1980s and led to the defunding of NGOs suspected of unsympathetic policy tendencies. The relationship is less adversarial now, but the financial drought has been relieved only in part as a consequence of tight discretionary budgets. It is worth observing that these various calamities had scant effects on those technical enterprises classified as quangos, where the special relationships with sponsor agencies actually resulted in a number of instances in significant growth of support, utilization, and confidence.

Do we perceive that the crest of NGO growth and multiplication has been passed and that the social and political forces propelling saturation have run their course? That is what the tea leaves seem to say. But what may seem to be so as regards the collective universe of nongovernmental organizations may apply only in degree to the scientific and technological subset, at any rate to its more dynamic components. The profiles of the stronger NGOs continue to be robust, while the frustrations and problems abound in the choices confronting government domestically and in the perplexing, changing world economy.

The commerce of query and response between government and NGOs is active and unabated. *In the view of the Task Force the potential of scientific and technical organizations to supply added value to the policymaking organs still is far from fully tapped.* In fact, though total policy consensus is unlikely on any important national choices, NGOs in some areas have a clearer and better record for policy formulation and workable consensus

than is the case with primary instruments of government. Moreover, the emergence of new forms of NGOs, designed expressly to resolve the regulatory standoffs between government and sectors of the industrial economy, is drawing government's attention to unsuspected benefits for public administration from the adaptabilities of the instrument.[40] The inherent limitations of government bureaucracies and for-profit business enterprises strengthen the case for NGOs, seemingly ratcheted upward with each spurt of public doubt in the ability of the government and industry to address social problems.

THE INTERNATIONAL DIMENSION

The domestic trend may be seen as part of a global growth of NGOs. From Amnesty International to Zonta International, in 1992 over 1,300 nongovernmental organizations around the world were officially accredited by and worked in partnership with the United Nations, a jump from only 48 in 1989.[41] Many of the organizations are concerned with science and technology (Box 5), reflecting the internationalization of scientific issues and research.

The growth of NGOs in the nations of the South, the former Soviet Union, and elsewhere is not tidy, as is the case with any democratic process. The new NGOs have had to learn all at once how to perform credible analyses, how to influence government policy, educate their constituents, and raise money. In many countries, they are a new phenomenon and quite awkward for governments unfamiliar with being prodded to respond to unmet needs in health, education, environment, and other fields.

The process of global consultations leading up to the June 1992 Earth Summit in Rio de Janeiro was a powerful testament to the vitality and influence of the NGO community on world issues. Throughout the preparatory process of regional and international meetings, national and international NGOs participated in developing the Summit agenda and content. This was a first. At earlier UN gatherings, NGOs were invited often at the last minute as an afterthought, and then only to separate "unofficial" sessions. The Global Forum in Rio, attended by tens of thousands of people from NGOs from all corners of the globe, was a dramatic demonstration of the size and strength of the international NGO movement (see Figure 6).

Within individual international NGOs and the larger community of NGOs there are sensitive issues of balancing the financial resources of the advanced industrialized countries with the egalitarian culture typical of many NGOs. And the same complex relationships that exist between national governments and national NGOs recur between intergovernmental

Box 5. International NGOs

The **African Network for Integrated Development**, based in Senegal, seeks to foster the use of science and technology for sustainable development and influence the development strategies supported by the World Bank and the African Development Bank.

Ashoka: Innovators for the Public is a U.S.-based organization scouting developing countries for talented, imaginative individuals who can bring entrepreneurial skills to the solution of social problems. Named after an Indian emperor remembered for his enterprise in social reform, Ashoka currently funds more than 400 fellows around the world.

Bangladesh Rural Advancement Committee is one of the world's largest development NGOs, with a staff of more than 2,000 in one of the world's poorest countries. It is a leader in nonformal primary school education and implements numerous technical programs for bilateral and multilateral governmental development agencies.

The **International Council of Scientific Unions** (ICSU) addresses matters of common concern to all scientists, such as the teaching of science, data, free circulation of scientists, and science and technology in developing countries. ICSU serves as a major bridge between the international scientific community and governments and intergovernmental organizations on the design and conduct of international research efforts, such as the World Climate Research Program. ICSU carries out much of its advisory work through scientific committees with members from many countries.

The **International Institute for Applied Systems Analysis** (IIASA) is a nongovernmental research institution sponsored by scientific organizations from 15 countries. IIASA's objective is to bring together scientists from various countries and disciplines to conduct research in a setting that is nonpolitical and scientifically rigorous. It aims to provide policy-oriented results that deal with issues transcending national boundaries.

International Physicians for the Prevention of Nuclear War (IPPNW) is a federation of national physicians' organizations comprising about 200,000 doctors, medical students, health workers, and others in almost 80 countries. IPPNW, which received the Nobel Peace Prize in 1985, seeks to inform the public about the hazards of war and prevent all forms of warfare.

organizations such as the United Nations and NGOs working internationally. Other Commission reports have called for more systematic partnerships between the international scientific community and intergovernmental organizations and for steadier means to direct the power of U.S. S&T NGOs at problems of global development.[42]

Figure 6. The Global Forum at the UN Earth Summit in Rio de Janeiro, June 1992. Tens of thousands of people, representing NGOs from all over the world, attended the Global Forum to address issues of environment and development. (Photograph courtesy of the Women's Environment and Development Organization.)

■ **A study of problems and potentials of the international NGO scene in science and technology would be helpful to both NGOs and governments in the current period of rapid intensification of exchanges.**

CREATIVE TENSIONS

NGOs in science and technology, taken as a universe, have much to their credit in the setting of public service. Yet, as voluntary organizations in the

diverse family of democratic institutions, they continue to feel their way in an arena of unsettled goals and imperfect choices, where externalities spring surprises and uncertainty dogs the policymaker's itch for finality. If the universe of NGOs is overcrowded, at times a pluralistic confusion of expertise and issue advocacy that gets in its own way and resists norms of efficiency and the conservation of skills and resources, it operates, like the process of search and discovery, as a very human business. As much must be said for government, to be sure. This, too, is common ground.

It is worth keeping in mind that the relationship between government and scientific/technical NGOs will not, and should not, be without its rough patches, even outright conflicts over technical or policy substance as well as goals and priorities. In the early 1980s the National Academies and AAAS elected to take on the administration over the issue of government's attempts to impose what amounted to censorship on the transfer and open dissemination of significant unclassified research results. Feelings on both sides ran high for some years before the transformation in U.S.–Soviet Bloc relations. The tensions between government and some NGOs were similarly deep and unabashedly voiced regarding the merits and claims for the Strategic Defense Initiative (SDI). Today the meeting agendas of NGOs find scientists and bureaucrats sometimes on opposite sides over the needs of Big Science projects versus those of smaller-scale project research and the limits of appropriate applied biological experimentation. On the interpretation of indicators of climatic change, the U.S. Government is surrounded, with some vocal and well-credentialed groups asserting that calamity is at hand and others saying the argument is flimsy.

Dissent has its rightful function in the interactions of NGOs with government. Indeed, it is well to recall that NGOs quarrel with one another at least as much as with government. Dissent, even to the level of confrontation, is implicit in the representational character of scientific and engineering organizations. NGOs cannot be asked to trade their independence and institutional values for government's goodwill for the sake of a false peace or serve their own immediate purposes.

Government-bashing for its political or media value, when wrapped in the borrowed legitimacy of scientific or technical authority, on the other hand, discredits the legitimate uses of responsible dissent. At bottom, the aspirations of NGOs to a constructive sharing in the policymaking process hang upon several factors: government's receptivity; timely reconfiguring of the structure and practices of the NGO universe; and a greater consistency of quality of NGO inputs to that process.

As to the first factor, it is the hope of this Task Force that government will take seriously the comprehensive proposals that have flowed and will continue to flow from the studies of the Carnegie Commission for procedural

and systemic upgrades of the policy machinery. As to the second, we look to the governing bodies of the NGOs to examine their roles and objectives more critically, with an eye to bringing greater synthesis and structural order to the existing patterns of runaway pluralism. And with respect to our third counsel, we point out that the assurance of high quality and reliability is crucial to earning government's confidence so that it will reach out for technical and policy advice on choices that bear upon scientific and technical assessments. That quality comes from building analytic assets and interpretive capabilities in sufficient depth and range to match the complexity of the dilemmas and choices faced by society today. Neither one-dimensional policy advocacy nor quotable one-liners for the news bites substitute for NGO advice derived from solidly grounded and reviewed analysis.

LOOKING TO THE FUTURE

Looking to a future in which policymaking is unlikely to find clear highways to consensus, NGOs in science and technology can expect increasing encounters with the decision-making and public administration structures at all levels, national and international, state and local. In some key respects they are ready; in others they are not. Not a great deal more is to be claimed on government's side, although proposals being addressed by other Carnegie study groups to the President, the Congress, and the Judiciary would, if implemented, better position the governance system to respond. NGOs, by and large, are not built into the structured arrangements through which government decides what—and what not—to do, or when, and how it is best done. There are, however, significant elements of the independent sector with lines of sight forward, backward, and even laterally that, when trained on complex tradeoffs and choices, can be of material, if unsung, help.

In the face of unmistakable growth of the scientific and technical NGOs, together with the parallel growth in allied sectors such as environment and health, the Task Force suggests that the United States has experienced a structural shift and realignment of the postwar framework on which the relationship of government with industry and academia took form. That three-dimensional paradigm appears to have undergone a change with the emergence of NGOs as a fourth dimension. The marketplace for NGO advice and engagement with governments has become lively and demanding. As scientific and technical content spreads through ever-multiplying problems of choice, the tradeoffs are too elusive, complex, novel, and trying for government to work out by itself. The roles open to scientific and technical organizations in the independent sector are real, emergent, and compelling.

APPENDIXES

APPENDIX A
SOME REPRESENTATIVE NGOs IMPORTANT TO SCIENCE AND TECHNOLOGY

The **American Academy of Arts and Sciences** was established by the Province of Massachusetts Bay in 1779. The purposes of the Academy are

> to promote and encourage the knowledge of the antiquities and the natural history of America; to determine the uses to which the various natural productions of the country may be applied; to promote and encourage medical discoveries, mathematical disquisitions, philosophical enquiries and experiments, astronomical, meteorological and geographical observations, and improvements in agriculture, arts, manufacture, and commerce; and, in fine, to cultivate every art and science which may tend to advance the interest, honor, dignity, and happiness of a free, independent, and virtuous people.

Academy activities are carried out primarily by its elected Fellows. Current subjects of Academy study include impacts of the genetic revolution and the relationships between environmental degradation and violent conflict. Academy expenditures are about $5 million/year. The Academy is the U.S. member organization for the International Institute for Applied Systems Analysis, an international NGO that provides advice to intergovernmental organizations.

The **American Association for the Advancement of Science** is America's largest general-purpose scientific society, with over 130,000 members. It is open to all dues-paying members, many of whom join to receive its weekly magazine, *Science*, the highest-circulation journal of record for the scientific community. Among the ways AAAS shapes public policy are through its R&D Budget and Policy Program, which analyzes spending trends in the federal budget; its Science and Engineering Fellowship Program, which arranges for postdoctoral and midcareer scientists to work for extended periods in the Congress and Executive agencies such as EPA and the State Department; and its programs in areas such as Science, Arms Control, and National Security, which organize seminars for congressional and other policymakers. Of its annual budget of about $40 million, about 70 percent derives from revenues for *Science* and associated member dues, and the balance from grants and other sources. Most of the members of the Board of Directors of the AAAS are directly elected by the membership. More than 300 other scientific and engineering societies are affiliated with the AAAS (see Appendix B), providing a network of communication that in practice has been rarely used in recent years.

The **American Association of Engineering Societies** (AAES) is a multidisciplinary organization of about 20 professional engineering societies dedicated to advancing the knowledge, understanding, and practice of engineering in the public interest. The member societies represent over half a million engineers. The AAES provides a means for member societies to exchange views and to coordinate efforts in the provision of information to the public concerning issues that affect the field of engineering as a whole. The annual budget of the AAES in recent years has been $1–$2 million. Reflecting chronic problems in achieving an umbrella organization for the engineering profession, the AAES almost dissolved in 1983, when several major societies dropped out. The AAES Board is comprised of twelve presidents and twelve executive directors of member societies; the former typically turn over each year, and the latter, who remain, have as a prime concern the protection of the respective domains of their own organizations.

The **American Chemical Society** is the largest of the scientific disciplinary societies, with about 140,000 members, about half in industry. Founded in 1876, the Society received a congressional charter in 1938 to

> encourage in the broadest and most liberal manner the advancement of chemistry in all its branches . . . thereby fostering public welfare and education, aiding the development of our country's industries, and adding to the material prosperity and happiness of our people.

When called upon by the military, ACS is to experiment and report upon chemistry matters connected with national defense; in practice this injunction has not been utilized. The Society has an annual budget of about $150 million, of which about three-quarters is devoted to publication activities, especially *Chemical Abstracts*. The Washington staff tracks legislation and agency regulations. A stream of policy positions are transmitted annually to the Congress and executive officials on matters

such as environment, risk analysis, and tax policy. Each April ACS organizes a "lobbying day," when members gather on Capitol Hill to advance Society positions.

The **American Physical Society**, founded in 1899, has 40,000 members, including educators, researchers, and students of physics and related fields. The Society maintains a small Washington office that produces a weekly newsletter including relevant information on legislative and executive agency developments available electronically to members at no charge. Through its panel on physics and public affairs, the APS has undertaken influential policy studies on issues where its members have special expertise; prominent among these were evaluations of the Strategic Defense Initiative and particle beam weapons. In such situations, the Society takes formal positions on matters of public policy guided by resolutions that have been adopted.

Computer Professionals for Social Responsibility was established in 1982 to conduct research and educational activities on policy issues related to computer and information technologies. CPSR has more than 20 chapters around the United States. Membership is open to all dues payers, with contributions starting at $15 a year for students and low-income members. Among the subjects of its studies have been the validity of computer vote counting, the reliability of computers in battle, computer viruses, and data protection. The CPSR focuses its public policy activities on the Congress, where, for example, it has delivered telling testimony on pending privacy-related legislation.

The **Connecticut Academy of Science and Engineering** was formed in 1976, with the express purpose of providing "guidance to the people and the government of the State of Connecticut, upon request, in the application of science and engineering to the economic and social welfare." The Academy carries out its work largely through volunteer study committees of its members, who are elected for distinguished contributions in research, the applications of research, and education. The Governor and the Commissioner of Economic Development of the state recently invited the Academy to prepare a plan for the development of a state science and technology policy. CASE has also recently responded to requests from the state Department of Health Services for advice on electromagnetic field health effects and from the Department of Economic Development on establishment of a Connecticut biotechnology center. For fiscal year 1991 CASE's contracts with the state were $106,000.

The **Council of Scientific Society Presidents** is an organization of presidents, presidents-elect, and immediate past presidents of about sixty scientific societies whose combined membership exceeds one million. The purposes of the CSSP include communication and cooperation among scientific disciplines and development of policy positions on research and education issues of national and international scope. Formed in 1973, the CSSP is funded by dues from the supporting societies and contributions from institutional affiliates. At its biannual meetings, the Council adopts policy statements recommended by its committees on such issues as the appropriate use of animals in research, exchange of scientific information,

science and mathematics education, and merit review of federally supported science projects. Views expressed by the CSSP represent a consensus of its members but do not necessarily represent the official positions of their respective organizations.

The **Council on Competitiveness** was created in 1986 to seek and promote consensus among public and private sector leaders on how best to improve U.S. competitiveness in world markets. The CC was formed in large part to sustain the work and implement the recommendations of the President's Commission on Industrial Competitiveness, which reported in 1985. Members of the CC are drawn from corporate, educational, and labor organizations. The annual budget of about $1 million comes from a sliding scale of contributions of participating organizations. The CC has offered several detailed policy agendas for the federal government with a large science and technology component. The Council draws on the resources of its national affiliates, more than two dozen trade associations, professional societies, and research organizations.

The **Health Effects Institute** is a nonprofit organization established in 1980 for the purpose of researching and reporting on the health effects of motor vehicle emissions and, additionally, the health effects of other environmental pollutants, and to provide the results of such research to the public and interested government agencies. Support for HEI consists principally of unrestricted contributions from motor vehicle and engine manufacturers and grants from the U.S. Environmental Protection Agency. Industry and the EPA share equally in the support of most HEI activities. In recent years HEI has spent about $7 million per year. HEI's scientific program is maintained and protected by two autonomous scientific committees, one of which formulates the research agenda and makes funding recommendations, while the other evaluates completed projects and puts their findings into broader regulatory and scientific perspectives. HEI is governed by an independent board to insulate it from both industry pressures and regulatory politics.

Independent Sector, founded in 1980, has as members some 650 corporations, foundations, and national voluntary organizations; associates are professionals of local, state, and regional organizations as well as individuals who are active volunteer leaders. Its purposes are to "preserve and enhance our national tradition of giving, volunteering and not-for-profit initiative"; educate the public about the role of the independent nonprofit sector; conduct research on the independent nonprofit sector and its usefulness to society. Independent Sector engages in government relations in order to assure the continuance of a healthy independent nonprofit sector and encourages effective management of philanthropic and voluntary organizations.

Established in the late 1930s, the **Industrial Research Institute** is an independent NGO consisting of a network of 250 corporate research directors focused upon advancing the effectiveness of industrial research. Founded originally by the National Research Council, IRI seeks common ground and organizes linkages among industry, government, and universities. IRI's interactions with government are carried out

through a Federal Science and Technology Committee. In 1990, IRI issued a position statement calling on the federal government to establish within government an IRI-type organization, the Federal Research Institute, designed to bring together leaders of the federal research and development agencies and laboratories to enhance the effectiveness of government research by focusing on managing the process of research and development.

The **Institute of Electrical and Electronics Engineers** (IEEE), founded in 1884, is a transnational organization comprising more than 300,000 members of whom more than 200,000 live and work in the United States. As the world's largest engineering society, IEEE's purposes are technical, educational, and professional. The United States Activities Board is the IEEE entity that addresses U.S. Government public policy issues. The IEEE supports Congressional Fellows and coordinates its public policy programs through a Washington office. In addition to prepared testimony, the IEEE has provided tutorials for Congress on such matters as robotics, photovoltaics, supercomputers, and intellectual property. The IEEE periodically prepares a "Federal Legislative Agenda" to acquaint Congress and the executive agencies with membership interests and concerns. IEEE is unusual in opting for IRS 501(c)(6) status, which permits employment of lobbyists.

The **National Academy of Public Administration** was formed in 1967 as a nonpartisan, collegial society to advance the effectiveness of government at all levels through sound management and counsel on the practical implications of public policy. The Academy was chartered by Congress in 1984. The work of the Academy is carried out by its Fellows, who are elected by their peers and consist of practitioners and scholars of public administration, notably present and former members of Congress, cabinet officers, state government executives, city and county managers and mayors, and business and independent sector leaders with public service experience. Among the studies of NAPA related to science and technology are reviews of the management of the National Aeronautics and Space Administration and the Intramural Research Program of the National Institutes of Health. The annual expenditures of NAPA are about $2 million, with most funding coming from federal contracts for specific studies.

The **National Research Council** is the principal working arm of the corporate institution that includes the **National Academy of Sciences**, the **National Academy of Engineering**, and the **Institute of Medicine**. The Academy complex originated in an Act of Congress, passed in 1863, that incorporated the National Academy of Sciences as a private body to be dedicated to the furtherance of science and technology and available to advise the federal government upon request. Responsibility for the work of the NRC is shared by the NAS, the NAE and the IOM; the latter two were established in 1964 and 1970, respectively, by the NAS under its congressional charter. By its charter, the Academy complex is an ally of the federal government. Legally, however, it is a private, nonprofit, self-governing corporation. Most of its activities are undertaken at the request of the government. The Research Council

is governed by a 13-member board consisting only of elected members of the NAS, NAE, and IOM. Both elected members and other experts serve on the panels that carry out the specific studies of the complex. The Academy publishes some 200 reports per year and expends about $200 million per year, of which about three-quarters comes from federal contracts.

The **New York Academy of Sciences** is a 175-year-old general-purpose scientific and engineering society, open to all dues-paying members, now numbering about 40,000. Roughly 20 percent of the members are in the New York metropolitan area, and of the remaining 80 percent, about half are outside the United States. The NYAS conducts international and national as well as regional and local programs on subjects ranging from human rights to primary and secondary school math and science education. It sponsors about 25 research conferences annually, whose proceedings as well as the results of other meetings are published in its *Annals* series. The Academy also publishes the bimonthly magazine *The Sciences*. The New York Science Policy Association is operated by the Academy. The Academy is available to assist the governments of both New York State and New York City on technical questions. The annual budget of the Academy is about $9 million, almost entirely from private sources.

The **RAND Corporation** seeks to conduct objective and practical research through the use of multidisciplinary resources and close links with clients. RAND was incorporated in 1948 with funding from the Ford Foundation after a two-year period of gestation during which support came from the Army Air Force and the Douglas Aircraft Corporation. World War II had spawned several analytic units employing quantitative methods to identify the most effective and efficient approaches to defense objectives. Initially the Air Force was the sole sponsor of research at RAND, but in 1950 RAND started performing work for the Atomic Energy Commission, and later for the National Aeronautics and Space Administration and for Defense's Advanced Research Projects Agency. The move toward multiagency sponsorship created some difficulties for the Air Force, which regarded RAND as less responsive to its needs than at the outset. Currently, RAND, which spends about $100 million/year, is supported by many federal, state, and local governments, and by foundations and other private philanthropic sources. RAND has an endowment that supports several research and teaching positions and independent projects.

Resources for the Future is an independent nonprofit organization that advances research and public education in the development, conservation, and use of natural resources and in the quality of the environment. Established in 1952 with the aid of the Ford Foundation, it is supported by an endowment and by grants from foundations, government agencies, and corporations. Grants are accepted on the condition that RFF is solely responsible for the conduct of its research and the dissemination of its work to the public. RFF research is primarily in the social sciences, especially economic. RFF expenditures are currently about $8 million/year.

The **Scientists' Institute for Public Information** (SIPI), located in New York City, assists in the dissemination of scientific information to the press as well as the public

and the Congress on request, without any particular policy function. SIPI maintains a database of names of scientists with expertise on particular topics to whom it refers journalists when they are working on news stories and seek sources or commentaries. In addition, SIPI organizes seminars on emerging topics to help inform the members of the media about scientific and technical topics and to build contacts between the scientific community and the media. It has not been possible to fund SIPI's service functions on the basis of dues or fees; private foundation support continues to be critical.

Sigma Xi, The Scientific Research Society, has been since 1886 the honor society of scientists, and is, along with the AAAS, the major society whose membership spans all fields of science and technology. Its membership, exceeding 100,000, belongs to 500 chapters on university campuses and in government and industrial laboratories. About 80 percent hold a Ph.D. or M.D. degree. Election to Sigma Xi, made on the recommendations of members, recognizes research ability. About a quarter of Sigma Xi members are in physical sciences, a quarter in the biological sciences, a fifth in engineering, and the balance distributed among math and computer, agricultural, medical, and social sciences. Sigma Xi publishes the monthly magazine *American Scientist.* Its annual expenditures are about $6 million, primarily from dues, and its leadership is elected largely through its network of chapters.

The **Union of Concerned Scientists** is an independent, nonprofit organization of scientists and other citizens concerned about the impact of advanced technology on society. UCS is committed to national security policies that reduce the threat of nuclear war. UCS also works for environmentally sensitive energy policies and for nuclear power safety. Established as an informal faculty group in the Boston area in 1969, UCS now has about 100,000 sponsors nationwide. A tax-exempt organization, UCS conducts research and educational programs, publishes reports, and engages in public-interest advocacy in the legal, administrative, and legislative arenas.

APPENDIX B
ORGANIZATIONS AFFILIATED WITH THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (AAAS)*

The AAAS provides networking services for the set of affiliated societies on matters of common interest such as analysis of the federal research budget.

Academy of Criminal Justice Sciences
Acoustical Society of America
Alpha Epsilon Delta
American Academy of Arts and Sciences
American Academy of Forensic Sciences
American Academy of Otolaryngology, Head and Neck Surgery
American Alpine Club
American Anthropological Association
American Association for Dental Research
American Association of Anatomists
American Association of Blacks in Energy

* Source: AAAS, *1990/91 Handbook.*

American Association of Cereal Chemists
American Association of Colleges of Pharmacy
American Association of Dental Schools
American Association of Petroleum Geologists
American Association of Pharmaceutical Scientists
American Association of Physical Anthropologists
American Association of Physicists in Medicine
American Association of Physics Teachers
American Association of University Professors
American Astronautical Society
American Bryological and Lichenological Society
American Ceramic Society
American Chemical Society
American College of Cardiology
American College of Dentistry
American College of Radiology
American College of Rheumatology
American Dairy Science Association
American Dental Association
American Dietetic Association
American Economic Association
American Ethnological Society
American Fisheries Society
American Geographical Society
American Geological Institute
American Geophysical Union
American Industrial Hygiene Association
American Institute of Aeronautics and Astronautics
American Institute of Biological Sciences
American Institute of Chemical Engineers
American Institute of Chemists
American Institute of Physics
American Institute of Professional Geologists
American Kinesiotherapy Association, Inc.
American Library Association
American Mathematical Society
American Medical Association
American Medical Writers Association
American Meteorological Society
American Microscopical Society
American Nature Study Society
American Nuclear Society
American Oil Chemists' Society
American Ornithologists' Union
American Pharmaceutical Association

American Philosophical Association
American Physical Society
American Physical Therapy Association
American Physiological Society
American Phytopathological Society
American Political Science Association
American Psychiatric Association
American Psychoanalytic Association
American Psychological Association
American Public Health Association
American Society for Aesthetics
American Society for Biochemistry and Molecular Biology
American Society for Cybernetics
American Society for Engineering Education
American Society for Horticultural Science
American Society for Information Science
American Society for Mass Spectrometry
American Society for Microbiology
American Society for Pharmacology and Experimental Therapeutics
American Society for Photogrammetry and Remote Sensing
American Society of Agricultural Engineers
American Society of Agronomy
American Society of Animal Science
American Society of Civil Engineers
American Society of Clinical Hypnosis
American Society of Criminology
American Society of Heating, Refrigerating, and Air-Conditioning Engineers
American Society of Hospital Pharmacists
American Society of Human Genetics
American Society of Ichthyologists and Herpetologists
American Society of Limnology and Oceanography
American Society of Mammalogists
American Society of Mechanical Engineers
American Society of Naturalists
American Society of Plant Physiologists
American Society of Plant Taxonomists
American Society of Zoologists
American Sociological Association
American Solar Energy Society
American Speech–Language–Hearing Association
American Statistical Association
Animal Behavior Society
Anthropological Society of Washington
Archaeological Institute of America
Arctic Institute of North America

ASM International
Associacao Brasileira de Quimica
Association for Applied Psychophysiology and Biofeedback
Association for Computing Machinery
Association for Symbolic Logic
Association for the Study of Man–Environment Relations
Association for Women Geoscientists
Association for Women in Science
Association of American Geographers
Association of Clinical Scientists
Association of Earth Science Editors
Association of Ground Water Scientists
Association of Southeastern Biologists
Association of Voluntary Action Scholars
Astronomical Society of the Pacific

Behavior Genetics Association
Beta Beta Beta Biological Society
Biometric Society, Eastern and Western North American Regions
Biophysical Society
Botanical Society of America

Chi Beta Phi Scientific Fraternity
Computerized Medical Imaging Society
Computing Research Board
Conference Board of the Mathematical Sciences
Consortium on Peace Research, Education and Development
Cooper Ornithological Society
Council of Biology Editors
Crop Science Society of America

Eastern Psychological Association
Ecological Society of America
The Electrochemical Society, Inc.
Electron Microscopy Society of America
Entomological Society of America

Foundation for Science and the Handicapped

Geochemical Society
Geological Society of America
Gerontological Society of America

History of Science Society
Human Biology Council
Human Factors Society

Illuminating Engineering Society of North America
Industrial Research Institute

Institute of Electrical and Electronics Engineers
Institute of Environmental Sciences
Institute of Food Technologists
Institute of Industrial Engineers
Institute of Management Sciences
Institute of Mathematical Statistics
Institute of Navigation
Institute on Religion in an Age of Science
Instrument Society of America
International Association for Impact Assessment
International Communication Association
International Society for Educational Planning
International Society for the Systems Sciences
International Studies Association
International Technology Education Association

Junior Engineering Technical Society

Linguistic Society of America

Marine Technology Society
Mathematical Association of America
Medical Library Association
Midwestern Psychological Association
Mycological Society of America

National Association for Research in Science Teaching
National Association of Biology Teachers
National Association of Geology Teachers
National Association of Science Writers
National Center for Science Education
National Council for the Social Studies
National Council of Teachers of Mathematics
National Federation of Abstracting and Information Services
National Institute of Science
National Marine Educators' Association
National Organization for the Professional Advancement of Black Chemists and Chemical Engineers
National Science Supervisors Association
National Science Teachers Association
National Society of Professional Engineers
National Speleological Society
National Wildlife Federation
Nature Conservancy

Oak Ridge Associated Universities
Operations Research Society of America

Optical Society of America
The Orton Dyslexia Society

Paleontological Research Institution
Paleontological Society
Parapsychological Association, Inc.
Pattern Recognition Society
Phi Beta Kappa
Phi Sigma Biological Sciences Honor Society
Philosophy of Science Association
Phycological Society of America
Pi Gamma Mu, International Honor Society in Social Science
The Planetary Society
Policy Studies Organization
Population Association of America
Poultry Science Association

Rural Sociological Society

School Science and Mathematics Association
Scientists Center for Animal Welfare
Seismological Society of America
Sigma Delta Epsilon, Graduate Women in Science
Sigma Pi Sigma
Sigma Xi, the Scientific Research Society
Society for the Advancement of Chicanos and Native Americans in Science
Society for American Archaeology
Society for Applied Anthropology
Society for Clinical and Experimental Hypnosis
Society for Computer Simulation International
Society for Economic Botany
Society for Environmental Geochemistry and Health
Society for Epidemiologic Research
Society for Experimental Biology and Medicine
Society for Experimental Mechanics
Society for Industrial and Applied Mathematics
Society for Investigative Dermatology
Society for Neuroscience
Society for Psychophysiological Research
Society for Research in Child Development
Society for Social Studies of Science
Society for the History of Technology
Society for the Scientific Study of Religion
Society for the Scientific Study of Sex
Society for the Study of Evolution
Society for the Study of Social Biology

Society of American Foresters
Society of Biological Psychiatry
Society of Economic Paleontologists and Mineralogists
Society of Exploration Geophysicists
Society of General Physiologists
Society of Protozoologists
Society of Systematic Zoology
Society of Toxicology
Soil and Water Conservation Society
Soil Science Society of America
Southern Society for Philosophy and Psychology
Speech Communication Association

Tau Beta Pi Association

U.S. Federation of Scientists and Scholars
U.S. Metric Association

Volunteers in Technical Assistance

Western Society of Naturalists
Wildlife Management Institute
The Wildlife Society
World Population Society

AFFILIATED ACADEMIES OF SCIENCE

Alabama Academy of Science
American Institute of the City of New York
Arizona-Nevada Academy of Science
Arkansas Academy of Science
California Academy of Science
Southern California Academy of Sciences
Chicago Academy of Sciences
Colorado-Wyoming Academy of Science
Delaware Academy of Science
Florida Academy of Sciences
Georgia Academy of Science
Hawaiian Academy of Science
Idaho Academy of Science
Illinois State Academy of Science
Indiana Academy of Science
Iowa Academy of Science
Kansas Academy of Science
Kentucky Academy of Science

Louisiana Academy of Sciences
Maryland Academy of Sciences
Michigan Academy of Science, Arts, and Letters
Minnesota Academy of Science
Mississippi Academy of Sciences
Missouri Academy of Science
Montana Academy of Sciences
Nebraska Academy of Sciences
New Jersey Academy of Science
New Mexico Academy of Science
New York Academy of Sciences
North Carolina Academy of Science
North Dakota Academy of Science
Northwest Scientific Association
Ohio Academy of Science
Oklahoma Academy of Science
Oregon Academy of Sciences
Pennsylvania Academy of Science
Rochester Academy of Science
Academy of Science of St. Louis
South Carolina Academy of Science
South Dakota Academy of Science
Tennessee Academy of Science
Texas Academy of Science
Utah Academy of Sciences, Arts and Letters
Vermont Academy of Arts and Sciences
Virginia Academy of Science
Washington Academy of Science
West Virginia Academy of Science

APPENDIX C
MASTER GOVERNMENT LIST OF FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDCs), 1990*

DEPARTMENT OF DEFENSE

OFFICE OF THE SECRETARY OF DEFENSE

Administered by nonprofit institutions:

Institute for Defense Analyses, Arlington, VA
Logistics Management Institute, Bethesda, MD
National Defense Research Institute (RAND Corporation), Santa Monica, CA

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Administered by universities and colleges:

Software Engineering Institute (Carnegie Mellon University), Pittsburgh, PA

* For further information contact the Government Studies Group, Division of Science Resources Studies, National Science Foundation, telephone (202) 634-4636.

DEPARTMENT OF THE NAVY

Administered by nonprofit institutions:

Center for Naval Analyses, Arlington, VA

DEPARTMENT OF THE AIR FORCE

Administered by universities and colleges:

Lincoln Laboratory (Massachusetts Institute of Technology), Lexington, MA

Administered by nonprofit institutions:

Aerospace Corporation, El Segundo, CA
C_3 I Federal Contract Research Center (MITRE Corporation), Bedford, MA
Project Air Force (RAND Corporation), Santa Monica, CA

DEPARTMENT OF THE ARMY

Administered by nonprofit institutions:

Arroyo Center (RAND Corporation), Santa Monica, CA

Administered by universities and colleges:

Institute for Advanced Technology (University of Texas), Austin, TX

DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTES OF HEALTH

Administered by industrial firms:

Frederick Cancer Research Facility (Program Resources, Inc.; Bionetics Research, Inc.; Harlan Sprague Dawley, Inc.; Data Management Services, Inc.), Frederick, MD

DEPARTMENT OF ENERGY

Administered by industrial firms:

Bettis Atomic Power Laboratory (Westinghouse-Electric Corp.), Pittsburgh, PA
Hanford Engineering Development Laboratory (Westinghouse-Hanford Corp.), Richland, WA
Idaho National Engineering Laboratory (E,G&G; Idaho, Rockwell International

Corporation; Argonne National Laboratory, West; Westinghouse Electric Corporation), Idaho Falls, ID
Knolls Atomic Power Laboratory (General Electric Company), Schenectady, NY
Energy Technology Engineering Center (Rockwell International Corporation), Canoga Park, CA
Oak Ridge National Laboratory (Martin Marietta Energy Systems Corporation), Oak Ridge, TN
Sandia National Laboratories (AT&T Technologies, Inc.; Sandia Corporation), Albuquerque, NM
Savannah River Laboratory (E.I. du Pont de Nemours & Co.), Aiken, SC

Administered by universities and colleges:

Ames Laboratory (Iowa State University of Science and Technology), Ames, IA
Argonne National Laboratory (University of Chicago and Argonne Universities Association), Argonne, IL
Brookhaven National Laboratory (Associated Universities, Inc.) Upton, Long Island, NY
Continuous Electron Beam Accelerator Facility (Southwestern Universities Research Association), Newport News, VA
E. O. Lawrence Berkeley Laboratory (University of California), Berkeley, CA
E. O. Lawrence Livermore National Laboratory (University of California), Livermore, CA
Fermilab (Universities Research Association, Inc.), Batavia, IL
Los Alamos National Laboratory (University of California), Los Alamos, NM
Oak Ridge Associated Universities, Oak Ridge, TN
Plasma Physics Laboratory (Princeton University), Princeton, NJ
Stanford Linear Accelerator Center (Stanford University), Stanford, CA

Administered by nonprofit institutions:

Inhalation Toxicology Research Institute (Lovelace Medical Foundation), Albuquerque, NM
Pacific Northwest Laboratory (Battelle Memorial Institute), Richland, WA
Solar Energy Research Institute (Midwest Research Institute), Golden, CO

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Administered by universities and colleges:

Jet Propulsion Laboratory (California Institute of Technology), Pasadena, CA

NATIONAL SCIENCE FOUNDATION

Administered by universities and colleges:

National Astronomy and Ionosphere Center (Cornell University), Arecibo, PR
National Center for Atmospheric Research (University Corporation for Atmospheric Research), Boulder, CO
National Optical Astronomy Observatories (Association of Universities for Research in Astronomy, Inc.), Tucson, AZ
National Radio Astronomy Observatory (Associated Universities, Inc.), Green Bank, WV

NUCLEAR REGULATORY COMMISSION

Administered by nonprofit institutions:

Center for Nuclear Waste Regulatory Analyses (Southwest Research Institute), San Antonio, TX

APPENDIX D
RAND CORPORATION*

Recent government-related projects in the civil sector have resulted in the following reports:

Health Insurance: The Tradeoff between Risk-Pooling and Moral Hazard
Medicare Patients and Postacute Care: Who Goes Where?
Effects of Mental Health Insurance: Evidence from the Health Insurance Experiment
Costs and Financing of Care for AIDS Patients: Results of a Cohort Study in Los Angeles
Precollege Science and Mathematics Teachers: Supply, Demand and Quality
Indicators for Monitoring Mathematics and Science Education: A Sourcebook
Multiplying Inequalities: The Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science

* Information from the 1989–1990 RAND Corporation Annual Report.

Prospects for Preventing Drug Use among Young Adolescents
Ethnicity, Geography, and Occupational Achievement of Hispanic Men in the United States
Development of High Definition Television: A Study in Japan–U.S. Trade Relations
Terrorists and the Potential Use of Biological Weapons: A Discussion of Possibilities

Seven research institutes at RAND are funded completely by federal sponsors:

Center for Aging Studies
Center for the Study of Employee Health Benefits
Defense Manpower Research Center
National Center for Research on Vocational Education
Population Research Center
RAND Strategy Assessment Center
RAND/UCLA/Harvard Center for Policy Research in Health Care Financing

There are nearly sixty major sponsors of RAND research:

Department of Defense
Department of Agriculture
Department of Health and Human Services
Department of Education
Department of Justice
Department of Labor
National Aeronautics and Space Administration
National Science Foundation
Prospective Payment Assessment Commission
Carnegie Corporation of New York
Central Intelligence Agency
Department of State
The Ford Foundation
J. Howard Pew Freedom Trust
Sandia National Laboratories
University of Chicago
Aetna Life and Casualty Foundation, Inc.
Allegheny Conference on Community Development
American Corporate Counsel Association
The Edna McConnell Clark Foundation
The Commonwealth Fund
Foundation for Chiropractic Education and Research
The John A. Hartford Foundation, Inc.
Health Data Sciences Corporation
Health Insurance Association of America
The William and Flora Hewlett Foundation
Indonesia Ministry of Health
Jet Propulsion Laboratory
Lilly Endowment Inc.
Los Angeles County
The John D. and Catherine T. MacArthur Foundation
The Markle Foundation
The Andrew W. Mellon Foundation
New England Medical Center
New York Health and Hospitals Corporation
John M. Olin Foundation, Inc.
The Pew Charitable Trust
Port Authority of New York and New Jersey
The Prudential Foundation
Queen's University

The Rockefeller Foundation
Russell Sage Foundation
Scientific Institute for Communications Services, German Federal Post
The Skillman Foundation
Alfred P. Sloan Foundation
The Spencer Foundation
The Starr Foundation
State of California, Commission on Teacher Credentialing
Teachers College, Columbia University
United States–Japan Foundation
University of California, Berkeley
University of California, Los Angeles
University of Michigan
University of Minnesota
Weingart Foundation

APPENDIX E
BIOGRAPHIES OF TASK FORCE MEMBERS

William D. Carey (co-chair) is a senior consultant to Carnegie Corporation of New York. From 1975 to 1987 Mr. Carey served as chief executive officer of the American Association for the Advancement of Science, following a long career in the Bureau of the Budget (now Office of Management and Budget) in the Executive Office of the President. Educated in public law and government, Mr. Carey is a past trustee of the Russell Sage Foundation, the MITRE Corporation, and the National Academy of Public Administration and former *ex officio* member of the governing board of the National Research Council.

Charles McC. Mathias, Jr. (co-chair) is with the law firm Jones, Day, Reavis & Pogue in Washington, DC. From 1969 to 1986 Mr. Mathias represented Maryland in the United States Senate, having earlier served four terms in the House of Representatives. Mr. Mathias has recently taken an active role through several nongovernmental channels in promoting the democratic restructuring of Eastern Europe and the former Soviet Union.

Oakes Ames is an Empire State Fellow in Science and Technology at the New York Academy of Sciences, where he also served as executive director from 1989 to 1991. Dr. Ames was trained in physics at Harvard and Johns Hopkins and taught physics at Princeton and the State University of New York at Stony Brook. From 1974 to 1988 he was president of Connecticut College.

Anne W. Branscomb is a communications lawyer currently conducting research at Harvard University on the impact of information technologies on property rights. Ms. Branscomb has served as a consultant to the Office of Technology Assessment, the Department of State, the RAND Corporation, the Aspen Institute and other corporate and nonprofit organizations. She has been active in the Science and Technology Section of the American Bar Association and has served on the National Conference of Lawyers and Scientists.

Harvey Brooks was dean of engineering and applied physics at Harvard University from 1957 to 1975. A solid state physicist, he worked in atomic power for the General Electric Company before joining Harvard. After his tenure as dean Dr. Brooks became Peirce Professor of Technology and Public Policy and one of the founders of the program in science, technology, and public policy at the Kennedy School of Government. Dr. Brooks has served on the President's Science Advisory Committee and the National Science Board and is a member of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

Mary E. Clutter is the assistant director for biological sciences of the National Science Foundation (NSF). Trained in botany, Dr. Clutter was a member of the faculty of Yale University before coming to NSF. Dr. Clutter serves on several policy-level committees, including the Board of Trustees of the International Human Frontiers Science Program and the Army Science Board. Dr. Clutter has served as a member of the board of the American Association for the Advancement of Science and has been active in the American Society for Cell Biology, American Society of Plant Physiologists, Sigma Xi, and the Association for Women in Science.

Edward E. David, Jr., is president of EED, Inc., consultants to industry and government on technology and research management. Dr. David's previous positions include science advisor to the President of the United States; president, Exxon Research and Engineering Company; and executive director, Bell Telephone Laboratories. He has been active in state affairs, serving with the New Jersey Commission on Science and Technology. Dr. David is a member of the National Academy of Sciences and the National Academy of Engineering.

William Drayton is the chair and president of Ashoka: Innovators for the Public, an international nonprofit organization that helps Third World individuals with exceptional entrepreneurial talent launch innovative nonprofit development or other ventures for the public good. Mr. Drayton is of Counsel to McKinsey and Company and was elected a MacArthur Fellow in 1984. Trained in law and economics, Mr. Drayton was assistant administrator of the U.S. Environmental Protection Agency from 1977 to 1981.

Lilli S. Hornig is senior consultant to Higher Education Resource Services, located at Wellesley College; she was its founder and was executive director from 1972 to 1984. Trained in chemistry at Bryn Mawr and Harvard, Dr. Hornig worked in Los Alamos, N.M., during World War II and then took up academic appointments at Brown and other universities. From 1974 to 1983 Dr. Hornig chaired the National Research Council Committee on the Education and Employment of Women in Science and Engineering.

Richard A. Meserve is a partner with the Washington, DC, law firm of Covington & Burling. His practice focuses on legal issues that involve substantial technical content, including environmental litigation, nuclear licensing, and high-technology exports. He has chaired the National Research Council committees to oversee the DOE nuclear weapons complex and

to assess safety at DOE reactors. Trained in law and applied physics, Dr. Meserve served for four years as legal counsel to the President's Science and Technology Advisor. He currently co-chairs the American Association for the Advancement of Science and American Bar Association National Conference of Lawyers and Scientists.

Charles W. Powers is founding partner of Resources for Responsible Management, a Boston firm devoted to work on management ethics and improving public–private-sector collaboration on controversial public issues. Dr. Powers was the founding executive officer of several major nonprofit institutions designed to resolve environmental conflicts between government and industry, including the Health Effects Institute, Clean Sites, Inc., and the Institute for Evaluating Health Risks. Earlier, Dr. Powers worked for Cummins Engine Company and taught at Yale University.

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John E. Sawyer is president emeritus of the Andrew W. Mellon Foundation, where he served from 1974 to 1987. From 1961 to 1973 Dr. Sawyer was president of Williams College. Trained in economic history, Dr. Sawyer had earlier served on the faculty at Harvard and Yale, after four years in the Research and Analysis Branch of the Office of Strategic Services. Dr. Sawyer has served as a director of the American Association for the Advancement of Science and council member of the American Philosophical Society and the American Academy of Arts and Sciences.

Marcia P. Sward is executive director of the Mathematical Association of America, a 27,000-member organization devoted to the interests of collegiate mathematics. Trained at Vassar and the University of Illinois, Dr. Sward taught for 11 years before becoming the founding executive director of the National Research Council's Mathematical Sciences Education Board, which provides a national overview and assessment capability for mathematics education. Dr. Sward has also been active in the American Mathematical Society, the Mathematical Association of America, and Sigma Xi.

F. Karl Willenbrock is a senior scientist in the Technology Administration of the Department of Commerce. Trained in applied physics, Dr. Willenbrock served on the faculty at Harvard, State University of New York at Buffalo, and Southern Methodist University, where he was also Dean of Engineering. From 1970 to 1976 Dr. Willenbrock was director of one of the institutes of the National Bureau of Standards, and from 1989 to 1991 he served as an assistant director of the National Science Foundation. From 1986 to 1989 Dr. Willenbrock was exec-

utive director of the American Society for Engineering Education. He has served as president of the Institute of Electrical and Electronics Engineers and as a member of the Council of the National Academy of Engineering.

Charles A. Zraket is president and chief executive officer emeritus of the MITRE Corporation, where he served in various capacities from 1958 to 1991. Educated in electrical engineering at Northeastern and MIT, Dr. Zraket began his career as a researcher in digital computation at MIT. He has served as an advisor, board member, or trustee with numerous groups concerned with national security, including the Hudson Institute, Center for Naval Analyses, Aspen Institute, and Harvard Center for Science and International Affairs. Dr. Zraket is a member of the National Academy of Engineering.

Jesse H. Ausubel is Director of Studies of the Carnegie Commission on Science, Technology, and Government and a Fellow in Science and Public Policy at The Rockefeller University. From 1977 to 1988 Mr. Ausubel was associated with the National Academy complex, serving as a fellow of the National Academy of Sciences, a staff officer with the National Research Council Board on Atmospheric Sciences and Climate, and director of programs for the National Academy of Engineering. He is the author of numerous publications in the field of environment.

NOTES AND REFERENCES

1. For historical background *see* H. Brooks (1986), "National Science Policy and Technological Innovation," pp. 119–167 in R. Landau and N. Rosenberg (eds.), *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, National Academy Press, Washington, DC; A. H. Dupree (1957), *Science in the Federal Government: A History of Policy and Activities to 1940*, Harvard University Press, Cambridge, Massachusetts.

2. J. E. Jankowski (1990), *National Patterns of R&D Resources: 1990*. 90–316. National Science Foundation, Washington, DC.

3. Aaron Wildavsky (1979), *Speaking Truth to Power*, Boston, Little Brown.

4. Dael Wolfle (1990), "The National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and the National Research Council," working paper prepared for the Carnegie Commission on Science, Technology, and Government. In 1991 some 7,000 volunteers participated in National Research Council studies.

5. Clifford Berg (1990), "The Role of Nongovernmental Organizations in S&T Policy Making," background paper prepared for the Carnegie Commission on Science, Technology, and Government.

6. William D. Carey, oral communication with Independent Sector staff.

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9. For background, *see* Alan Pifer (1967), "The Quasi Nongovernmental Organization," *Annual Report of the Carnegie Corporation of New York*, pp. 3–16; B. Smith (ed.), *The New Political Economy: The Public Use of the Private Sector*, Halsted, New York, 1975; D. Hague, W. J. M. Mackenzie, and A. Barker (eds.), *Public Policy and Private Interests: The Institutions of Compromise*, Macmillan, London, 1975.

10. Clifford Berg (1991), "Federally Funded Research and Development Centers," background paper prepared for the Carnegie Commission on Science, Technology, and Government.

11. Senate Subcommittee on Oversight of Government Management (Carl Levin, Chair), Senate Committee on Governmental Affairs, 8 July 1992, "Inadequate Federal Oversight of Federally Funded Research and Development Centers," p. 2; p. 18.

12. The field of negotiation, mediation, and conflict resolution is in general one of the fastest-growing areas of NGO activities. What is new is the attempt to treat dispute resolution as a rigorous scientific enterprise with a common theoretical base extending over many potential areas of application. An important fraction of the effort in the field involves S&T issues such as global warming. Interesting NGOs in the field include the National Peace Foundation, a privately supported NGO that complements the congressionally established and funded National Institute of Peace; both organizations are focused on research, education, and public outreach on techniques of negotiation and conflict resolution in the international arena.

13. Charles W. Powers (1991), "Breaking Gridlock: The Role of NGOs in Improving the Employment of Science and Technology in Environmental Management," background paper prepared for the Carnegie Commission on Science, Technology, and Government.

14. An example where the model may apply successfully is the possible health effects of electromagnetic fields (EMF). With such an issue, the efforts of major individual institutions able to design, support, and perform research and assessments, whether governmental or private, tend to be viewed with suspicion; a carefully balanced new bridging institution might be able to perform the needed tasks in an effective manner.

15. Clifford Berg, "Role of Non-Governmental Organizations in S&T Policymaking," paper prepared for the Carnegie Commission on Science, Technology, and Government, 1990.

16. This is one reason that constituency-building and public outreach are collateral functions of NGOs whose importance is increasingly recognized. Writing a high-quality report may be only the beginning rather than the end of an NGO policy study.

17. Annual Report 1989–1990, RAND Corporation, Santa Monica, Foreword.

18. The issue is raised from time to time of whether tax exemption is legitimate for activities with public policy implications that may have an impact on public opinion and that are therefore viewed as covertly political.

19. Alan K. Campbell and Linda S. Dix (eds.) (1990), *Recruitment, Retention, and Utilization of Federal Scientists and Engineers*, Committee on Scientists and Engineers in the Federal Government, National Research Council, A Report to the Carnegie Commission on Science, Technology, and Government. National Academy Press, Washington, DC.

20. It is worth noting that verbal communication is probably subject to distortion by the preconceptions of the recipient to a greater extent than written communication. There is also a tendency to tell the boss what she or he wants to hear. With a public report (written or oral), the author of the advice becomes accountable to a wider audience than the intended recipient of the communication. In certain cases, this may encourage intellectual honesty; in other cases, candor may be encouraged by confidentiality.

21. Lance B. Kurke and Howard E. Aldrich (1983), "Mintzberg was right!: A replication and extension of *The Nature of Managerial Work*," *Management Science* 29: 975–984.

22. Descriptions of experiences in the program are found in "Science and Congress: Essays by Former Congressional Fellows," George C. Sponsler (ed.), 7 November 1988, prepared for the Carnegie Commission on Science, Technology, and Government. The history of the program is in Michael L. Telson and Albert H. Teich, "Science Advice to the Congress: The Congressional Science and Engineering Fellows Program," pp. 447–452 in *Science and Technology Advice to the President, Congress, and Judiciary*, William T. Golden (ed.), Pergamon, Oxford, 1988.

23. For several years the Industrial Research Institute and the American Electronics Association financed S&T Fellows. This practice was recently stopped because of concerns over the appearance of conflict of interest associated with private sector funding, an issue that should be manageable through appropriate shared oversight of the Fellows program.

24. John E. Sawyer (1989), "How Firm Are Foundations?" *Proceedings of the American Philosophical Society*, 133(3).

25. Marc Rotenberg (1991), "Advocacy Organizations in the Formation of Science and Technology Policy," background paper prepared for the Carnegie Commission on Science, Technology, and Government.

26. Carnegie Commission on Science, Technology, and Government (1992), *Enabling the Future: Linking Science and Technology to Societal Goals.*

27. Carnegie Commission on Science, Technology, and Government (1991), *Science, Technology, and Congress: Expert Advice and the Decision-Making Process*, pp. 32–34.

28. Thomas L. Hughes (1991), "Pluralism and the Politics of Peace," *Cosmos: A Journal of Emerging Issues* 1:4–7 (Cosmos Club, Washington, DC).

29. Eleanor Chelimsky has argued that "The constraints . . . that have always affected the ability of researchers to inform decision-makers are still serious and widespread enough to obviate any inordinately optimistic view that current decisions are unambiguously better than those of a century ago." "On the Social Science Contribution to Governmental Decision-Making," *Science* 254:226–231 (p. 229).

30. Franklin A. Long (1991), "NGO Programs of U.S. Research Universities," background paper prepared for the Carnegie Commission on Science, Technology, and Government.

31. Carnegie Commission on Science, Technology, and Government (1991), *Science, Technology, and Congress: Expert Advice and the Decision-Making Process*, pp. 22–24.

32. The only full-time resident employees of the Academy complex who are elected Members are the Presidents of the NAS, NAE, and IOM. The other officers serve in a part-time capacity. In fact, as recently as the 1960s the President of the NAS held a concurrent major position as the head of a university.

33. Among the useful Academy publications are Philip M. Smith (1988), "The National Academy of Sciences, National Academy of Engineering, Institute of Medicine, National Research Council: The Policy Partnership with the U.S. Government," 24 pp.; "Questions and Answers about the National Academy of Sciences, National Academy of Engineering, Institute of Medicine, and the National Research Council," February 1989, 25 pp.; "The National Research Council: A Unique Institution" (undated), 32 pp.; and "Report Review: Guidelines for Committees and Staff." These documents are available from the National Academy of Sciences, 2101 Constitution Ave., NW, Washington, DC 20418.

34. The Task Force did not weigh in detail the merits of various alternatives in this regard. One option that has been mentioned from time to time is to move more in the direction of RAND, with stable block funding from the federal government, perhaps through a consortium of agencies, for a moderate fraction of the institution's budget. Under an umbrella agreement to provide a specified level of effort, task agreements to address specific problems could be arranged by straightforward negotiations. Such a mechanism might address concerns about the sometimes sluggish way proposals work their way through both federal and Academy bureaucracies, overhead levels, and difficulties in retaining key staff members dependent on contractual vagaries. In the late 1970s discussions were held involving the Congress and the Academy about the idea of a one-time congressional appropriation to establish an endowment held in trust by the U.S. Treasury whose interest would be made available annually to the Academy to strengthen its advisory role. Each option raises fundamental issues of the Academy's autonomy and dependency on government.

35. Carnegie Commission on Science, Technology, and Government (1991), *Science, Technology, and Congress: Expert Advice and the Decision-Making Process*, pp. 27–28, 34–35.

36. Carnegie Commission on Science, Technology, and Government (1992), *Science, Technology, and the States in America's Third Century.*

37. For a discussion of the chronic and serious threat to the nation's future posed by inade-

quacies in precollege math and science education, *see* Carnegie Commission on Science, Technology, and Government (1991), *In the National Interest: The Federal Government in the Reform of K–12 Math and Science Education.*

38. Marcia Sward, Lilli Hornig, and Oakes Ames (1991), "The Role of NGOs in Improving Science and Mathematics Education," background paper prepared for the Carnegie Commission on Science, Technology, and Government.

39. The Task Force notes the helpful *Working with Congress: A Practical Guide for Scientists and Educators*, published in 1992 by the AAAS to assist individual scientists and engineers in their interactions with the Congress. Perhaps somewhat analogous guides to the Executive Branch, the courts, and state governments might be considered.

40. Charles W. Powers (1991), "The Role of NGOs in Improving the Employment of Science and Technology in Environmental Management," background paper prepared for the Carnegie Commission on Science, Technology, and Government; L. Susskind and J. Cruikshank (1989), *Breaking the Impasse: Consensual Approaches to Resolving Public Disputes*, New York, Basic Books.

41. *World Times* XIV:8, August 1992 issue on "The NGO Revolution."

42. Carnegie Commission on Science, Technology, and Government (1992), *International Environmental Research and Assessment: Proposals for Better Organization and Decision Making.*

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