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STUDY BY THE STAFF OF THE U.S.

General Accounting Office

Major Science And Technology Issues

Developments in science and technology have an increasingly pervasive effect on the way we live. Consequently, public policy must continually address problems which have significant science and technology components.

In its various functions, the Federal Government performs, funds, and regulates science and technology. These Federal activities often require a balance among:

- --a need for more and better science and technology,
- --pressure for more accountability for the use of public funds, and
- --more attention to preventing the negative consequences of science and technology.

This study identifies emerging issues related to Federal involvement in science and technology and describes GAO's efforts in this area.

U.S. General Accounting Office

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PREFACE

"The race to the Moon and beyond, peaceful uses of nuclear energy, computerized typewriters--all are the product of science and technology, the backbone of the 20th century. They impinge upon virtually every aspect of life. Most every U.S. Government program is at least influenced by science and technology. Today's policymakers must make decisions about Government programs which will affect tomorrow's world. What should be done about the imminent world shortages of nonrenewable critical natural resources and the threat of irreversible ecological damage? And, these decisions must integrate scientific, technological, economic, political, institutional, and environmental considerations." 1/

This study identifies and describes what we believe are the critical science and technology issues facing the Nation. This study was originally prepared as an internal guide to focus our work in science and technology.

Our work is directed toward evaluations that address the

--organization and process of science and technology policymaking,

--science and technology resource base,

--relationships within the science and technology system, and

--application and diffusion of science and technology.

It is hoped that others will find this study useful and that it will give them a better understanding of what we view as important issues in the science and technology area.

Questions regarding this study should be directed to Howard Gobstein, Science Policy Analyst and Issue Area Coordinator, on (202) 275-3748.

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1/Elmer B. Staats, Comptroller General of the United States, "The General Accounting Office: Appraising Science and Technology Programs in the United States," in Interdisciplinary Science Reviews, March 1978, p. 7.

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ABBREVIATIONS

LOE	Line-of-effort
ISPT	Intergovernmental Science and Public Technology
ISETAP	Intergovernmental Science, Engineering and Technology Advisory Panel
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NRC	National Research Council
NSB	National Science Board
NSF	National Science Foundation
OMB	Office of Management and Budget
OST	Office of Science and Technology
OSTP	Office of Science and Technology Policy
OTA	Office of Technology Assessment
PCST	President's Committee on Science and Technology
R&D	Research and development

CHAPTER 1

OVERVIEW OF ISSUE AREA

BACKGROUND OF THE ISSUE AREA

Science is both a form of inquiry and the knowledge that results from that inquiry. Science is distinguished as a form of inquiry by an insistence upon empirical verification and by the goal of building increasingly more comprehensive theories about the working of the universe. Although scientific inquiry may be directed at virtually any subject that has some relationship to experience, the areas of scientific investigation are often divided into the physical, the biological, the psychological, and the social.

Technology may be broadly defined as the knowledge, skills, methods, and techniques regularly used to accomplish specific practical tasks. Prior to the 20th century, technology and science were only very loosely related. Technology was primarily the domain of inventors and craftsmen whose understanding of the scientific principles underlying their innovations and inventions was often recipe knowledge--they knew what worked but often had little understanding of why. Modern technology is often tied much more directly to scientific advance, although the lag between discovery and application remains quite long in many fields. The activities of the GAO Science and Technology group are concentrated in those areas of technological development in which the ties between scientific research and practical application are most pronounced (e.g., electronics, bioengineering).

Federal Government interest in science and technology

The Federal Government is interested in science and technology because science and technology are pervasive forces in our Nation and our world. There is almost no major national or international problem or issue which does not have a major science and/or technology component. Science and technology are cited as the sources of problems such as environmental pollution and cancer. They are invoked as the solution to problems such as energy and materials shortages. They are credited with making the United States a preeminent world power after World War II and then with the decline of that preeminence in the past two decades. Science and technology account for both problems and solutions in our world today. As such, they require substantial attention from the national Government of a country as scientifically and technologically sophisticated as the United States.

Evolution of the Federal role in science and technology

The Federal role in science and technology developed gradually in the United States until World War II, when rapid and dramatic changes took place. The Federal initiative in science began in the first part of the century with efforts to survey and chart an unexplored continent. It expanded to the support of scientific research in agriculture during the last half of the 19th century. In the first part of the 20th century, support for research in aeronautics was added.

With the advent of World War II, the Nation's science and technology institutions and resources were mobilized to support the allied war effort. This mobilization was strikingly successful, and science and technology came to be viewed as critical elements in the growth and development of the Nation as well as in the national defense. Proponents of an expanded Federal role in science were able to crystallize this perception into a resolution to continue the wartime support for science and technology into the postwar period. As a result, Federal support for scientific research expanded to include support for basic science in all fields.

In addition, the past 20 years have seen expansion in applied research and development (R&D) programs in nuclear physics, space, energy, environmental quality, health, communications, and transportation, as well as defense. The Federal role in science and technology has both grown and broadened in scope, taking increasing responsibility for maintaining the health of basic science, and supporting initiatives into more areas of applied technology. This expanded Federal support for both basic and applied science was largely responsible for making the United States preeminent in the sciences during the quarter century after the war.

Nature of the Federal role in science and technology

The Federal Government influences science and technology both directly and indirectly. The Federal Government directly supports science and technology by funding R&D through grants and contracts to researchers in universities and industry, developing and maintaining Federal laboratories, and supporting education in the sciences and engineering. More indirectly, the Federal Government influences science and technology technology through the patent system, tax incentives, the regulation of scientific activities, the dissemination of research results through information systems and technology transfer

programs, and the performance of research on techniques of measurement on which all science and technology rely.

The most familiar form of Federal involvement in science and technology is direct Federal funding of R&D. The level of Federal funding and its focus (e.g., military vs. civilian, basic vs. applied research) have changed substantially during the past 30 years. Federal spending on R&D grew from $8.7 billion in 1960 to $25.7 billion in 1979. Spending by private industry grew from $4.5 billion to $24.0 billion over the same period. While Federal nondefense R&D constituted only 14 percent of Federal R&D spending in 1960, it was 40 percent in 1979. Within Federal civilian R&D, applied research and development spending grew from 70 percent of the total in 1968 to 75 percent in 1976. There has thus been a shift from military R&D to civilian R&D, and civilian R&D has become increasingly applications oriented.

While Federal R&D support in fiscal year 1980 is still dominated by the Defense Department ($13.8 billion) and the National Aeronautics and Space Administration ($5.1 billion), funds are increasingly shifting to Health and Human Services ($3.8 billion), Energy ($4.9 billion), the National Science Foundation ($0.9 billion), Agriculture ($0.7 billion), the Environmental Protection Agency ($0.4 billion), Interior ($0.4 billion), Commerce ($0.4 billion), and Transportation ($0.4 billion). Other agencies added another $1.2 billion. In addition to providing R&D support for new technology, some Departments, notably Energy and Transportation, subsidize the capital expenditures necessary to bring new technology into commercial use.

CURRENT CONGRESSIONAL INTEREST IN SCIENCE AND TECHNOLOGY

Congressional interest in science and technology has increased with recognition of the pervasiveness of science and technology in our Nation and our world. Although jurisdiction for cross-Government science and technology policy issues resides primarily in two Committees--the House Committee on Science and Technology and the Senate Committee on Commerce, Science, and Transportation--almost every committee in Congress deals with some direct or indirect aspect of science policy.

The science and technology policy issues with which Congress has been most concerned in recent sessions fall into three major categories:

--The organization and governance of Federal science and technology activities.

--The strength of the science base.

--The Federal role in fostering innovation.

Concern with the organization and governance of Federal science and technology efforts is a perennial issue in science policy. Congress' recent interests in this area have been evidenced in:

--Oversight of the Office of Science and Technology Policy (OSTP) that has involved close examination of how well OSTP is performing their reporting and strategic planning functions.

--A proposal for a National Technology Foundation that would combine the innovation activities of the National Science Foundation (NSF) and the Department of Commerce (DOC) into one organization and make that organization the focal point for Federal innovation policies and programs.

--Examination of the extent and effectiveness of long-term planning for science and technology.

Recent congressional concerns about the strength of the science base have resulted in a variety of proposed actions:

--Multiyear authorization of R&D.

--Tax incentives to encourage investment by industry in basic research.

--Funding to encourage the education and employment of women in science.

--Increased funding for Federal science education programs.

Many of the proposals designed to strengthen the science base are also meant to improve the rate of innovation in the United States (e.g., tax incentives). In addition, recent congressional actions to foster innovation include:

--Promoting closer relations between universities and industry in order to encourage joint development of industrial technology.

--Examining the role of the National Bureau of Standards (NBS) in innovation and productivity to determine whether NBS could do more.

--Numerous proposals to facilitate innovation by small businesses, including R&D funding set-asides, tax incentives, and special patent rights.

--Patent reform.

Appendix I lists and briefly describes the major recent legislative proposals in science and technology policy.

SCOPE AND RESPONSIBILITIES OF THE GAO SCIENCE AND TECHNOLOGY ISSUE AREA

The responsibilities of the Science and Technology Issue Area encompass all aspects of science and technology which do not pertain solely to the mission responsibilities of a particular Federal agency. The Science and Technology Issue Area is concerned with the "cross-cutting" aspects of science and technology.

The primary purpose of GAO's work in science and technology is to support congressional oversight and decision-making on science and technology issues that cut across program areas. To provide this support, we initiate projects in anticipation of congressional needs and we respond to congressional requests for information and analyses. The Science and Technology Issue Area has six specific responsibilities:

- To assist Congress in the oversight of NSF.

- To provide staff support to the Comptroller General on all matters pertaining to science and technology policy.

- To provide information and advice to Congress on Government-wide aspects of science and technology policy, R&D, and program options by

  --framing and clarifying issues;
  --examining key assumptions and clarifying ambiguities;
  --identifying, defining, developing, and evaluating alternative policy and program options; and
  --monitoring and reporting on trends.

- To assist Congress in defining its needs for science and technology and R&D information, and to help strengthen the processes by which Congress can obtain and use timely and reliable information related to science and technology policy issues.

- To perform as liaison between GAO and major science and technology policy organizations and commissions, such as the OSTP, the National Academies of Sciences and Engineering, the American Association for the Advancement of Science, and the National Commission on Research.

- To coordinate and perform reviews of other GAO work with science and technology components and/or implications.

Although not assigned to the issue area, the function of serving as the principal GAO liaison and contact point for cooperation and coordination with the Office of Technology Assessment (OTA), and providing staff support to the Comptroller General in matters relating to the Comptroller General's role as a member of the OTA Technology Assessment Advisory Council, are charged to the Science and Technology Issue Area.

FUTURE TRENDS AND OUTLOOK

Our analysis of trends indicates that two broad sets of conflicting pressures will increasingly influence the outlook for U.S. science and technology:

--Pressures for more and better science and technology, and

--Pressures for more accountability for the use of public funds and more attention to preventing the negative consequences of science and technology.

The pressures for more and better science and technology result from the international economic situation, the health of the domestic economy, and the need to resolve major societal problems (e.g., energy and materials shortages and environmental pollution). The international economy is likely to grow increasingly competitive during the next decade. The long lead that the United States had in scientific and technological performance during most of the post-war period will almost certainly continue to erode. As other industrial countries achieve a position of rough parity with the United States in economic and scientific performance, there will be growing pressures to improve U.S. performance, and an important part of improving that performance will be increasing the contribution which science and technology make to the economy. Even in the absence of increased international economic competition, science and technology are being called upon to improve productivity and, hence, reduce inflation without increasing unemployment. Finally, major societal

require scientific and technological solutions, and pressure is mounting to achieve those solutions.

All of these pressures for more and better science and technology will tend to be felt most strongly at the point at which the results of scientific research are applied to practical ends; that is, where science is embodied in technology and commercialized. Innovation--the process of commercializing new technology--will thus be a concern of growing importance in the years ahead.

While pressures for more rapid development and application of science and technology grow, pressures are also growing for public accountability for science and technology. This demand for accountability takes the form both of financial accountability--making sure that public funds are spent prudently and in accordance with public priorities--and of a broader, more social form of accountability--making sure that the consequences of technology, regardless of who pays for it, are not detrimental to public interest.

The impetus for the pressures for accountability comes first from increasingly tight Federal budgets which in turn reflect declines in the domestic economy. Federal funding of science and technology is one of the few areas in which spending levels are not committed by long-term legislative mandate. As one of the few "controllable" expenditures, R&D tends to be reduced whenever pressures for budgetary reduction become great. The return on science and technology spending usually comes only in the future, so reductions in spending often have no immediate impact on the flow of benefits. The deteriorating economic situation referred to above, especially continuing inflationary pressures, will make pressures for budget reductions frequent over the next decade.

The demand for more control of the consequences of technology is the continuation of a trend which has been in progress for the past two decades. The environmental movement and the movement for better occupational safety and health have sensitized people to the potential dangers of technology. Public disillusionment with technology can be expected to continue to result in pressure for more regulation or other kinds of control over science and technology. These pressures may also be reflected in growing interest in a fundamental review of the way in which science is governed, and how the process of science policymaking works. There may be pressures to examine how adequately the science policymaking process incorporates a broad range of public views. Interest in how foresighted science policymaking is and how effectively it plans for the long term future is likely to increase.

In summary, the future of U.S. science and technology will be strongly influenced by two major forces which are likely to be in conflict: pressures for more and better science and technology to improve U.S. competitiveness and to resolve major societal problems; and pressures for more accountability for public funds used to support science and technology and for more control of the consequences of science and technology. At the same time, certain characteristics of science and technology will remain immutable. One of these is the serendipitous aspect of science and technology, the fact that scientific and technological breakthroughs often come from the least expected sources. The practical implication of this serendipity is that it will continue to be important for the Nation's various performers of scientific and technological research to maintain healthy relationships of communication and cooperation with one another. Maintaining the necessary balance between independence and cooperation will remain an important goal in Federal science policymaking for the foreseeable future.

MAJOR SCIENCE AND TECHNOLOGY ISSUES

Two broad issues are raised by the trends and outlook for science and technology and by the characteristic approaches of the Federal Government to science and technology matters:

--How can the United States effectively balance the need to develop and rapidly apply science and technology to national problems and opportunities with the need to insure the appropriate and effective use of public funds and to further the public health and safety?

--What is the appropriate scope and focus of the Federal role in science and technology? What are the appropriate objectives of the Federal role in science and technology?

The first of these broad issues results from the two major--and potentially conflicting--forces described in the previous section on future trends and outlook. The second issue grows out of the increasing importance and pervasiveness of science and technology in public policy, and the characteristic fragmentation of Federal Government approaches to science and technology. That fragmentation is reflected in Federal executive agency responsibilities, congressional committee jurisdictions, and incremental development of policies and programs.

More specific issues of current importance that are part of the need for balance between promoting the development and

application of science and technology and protecting the public interest include:

--What kind of Federal organization for science and technology will most effectively balance these needs?

--What kinds of policymaking procedures and inputs to the policymaking process will most effectively promote and maintain a balance--e.g., how can growing public concerns about the potential consequences of science and technology best be accommodated in the policymaking process?

--What kinds of policies, programs, and mechanisms (e.g., grants, contracts) will most effectively balance the need for flexible support of research with the need for accountability for public funds in an era of increasingly tight budgets?

--What kinds of relations among research performers (e.g., Federal Government-universities, universities-industry) will help to maintain an effective balance?

Specific issues related to the appropriate scope, focus, and objectives of the Federal role in science and technology include:

--What role should the Federal Government play in long-term planning for science and technology?

--What should be the Federal role in establishing a favorable policy environment to strengthen the U.S. industrial base and foster private investment in R&D, technological innovation, and capital formation?

--How far beyond support of basic research should Federal support for scientific and technological development extend--e.g., toward commercialization?

--What should be the balance of Federal support for: different fields of basic research? different fields of applied research?

-- What should be the Federal role in fostering more cooperative research arrangements between industry and universities?

--What should be the objectives of Federal efforts in science education? How extensive should Federal support for science education be?

--What are the appropriate science and technology roles and objectives of the Federal Government *vis a vis*: other research sponsors? State and local governments? other nations?

--What should be the appropriate scope, emphases, and objectives of Federal Government activities in science and technology information systems?

These issues provided the basis for the development of this program plan. They guided the delineation of areas-of-concern and lines-of-effort (LOEs), and the selection of emphases for our work during the next 18 months. Chapters 2 through 6 describe the areas-of-concern and LOEs that make up the Science and Technology Issue Area.

CHAPTER 2

IDENTIFICATION OF AREAS-OF-CONCERN AND LINES-OF-EFFORT

AREAS-OF-CONCERN

Science and technology is an extremely broad issue area. It encompasses the activities of dozens of different agencies and addresses issues which range from decisionmaking about Federal R&D funding to clarifying the United States position in science and technology.

To help guide our efforts in this broad and complex issue area, we have developed four areas-of-concern. Together these areas-of-concern form a conceptual framework that allows us to identify and classify the range of issues and activities that make up the Science and Technology Issue Area, and to show their interrelationships.

We developed these four areas-of-concern by focusing on what is needed (e.g., organizations, procedures, relationships) to perform the Federal role in science and technology effectively. We have assumed that the primary goals of Federal activities in science and technology are: to ensure that the science and technology resources needed to address national objectives are developed and effectively used; and to ensure the development of the Nation's science and technology base. Given these broad goals, the following must be present:

--An effective organization and process for setting science policy goals and objectives and designing programs to achieve those goals and objectives. This includes the organizational arrangements and procedures for making policy as well as the information, data, perspectives, and opinions that are used and the mechanisms of obtaining each. The focus here is on the effectiveness of the policymaking apparatus.

--A resource base consisting of knowledge, human resources, equipment, and R&D facilities, that are accessible and appropriate to the objectives to be achieved. These are the resources that are available to achieve the goals that are established for science and technology. The Federal role is to ensure that these resources are developed, maintained, and available to be used when needed. The focus here is on developing and maintaining these basic resources.

--Effective working relationships among the principal "actors" in the science and technology "systems," i.e.: among Government and other research performers (e.g., universities, industry); among different levels of Government; and between the United States and other nations. The focus here is on maintaining and improving these relationships in order to improve policymaking and the development and application of science and technology resources.

--Effective methods for disseminating and applying the appropriate science and technology resources. Concern here is with the ultimate uses and users of science and technology. The focus is on making the appropriate elements of science and technology available to the ultimate users and ensuring appropriate application of the elements of science and technology.

These four categories define our four areas-of-concern:

--The Organization and Process of Science and Technology Policymaking.

--The Science and Technology Resource Base.

--The Relationships Within the Science and Technology System.

--The Application and Diffusion of Science and Technology.

LINES-OF-EFFORT

The 4 areas-of-concern identify the universe for our work under the Science and Technology Issue Area. Under the 4 areas-of-concern, we have identified 12 LOEs that merit GAO's attention over the the next 18 months. Listed below are the 12 LOEs grouped by areas-of-concern.

o The Organization and Process of Science and Technology Policymaking

--What can be done to improve the information provided to Congress to support decisionmaking on R&D priorities?

--How should long-range planning for science and technology be carried out?

--How should the Federal Government be organized for science and technology policymaking?

- The Science and Technology Resource Base

  --How can NSF basic research policies and programs ensure appropriate balance among scientific accountability, financial accountability, and administrative effectiveness?

  --What can be done to address issues concerning the administration of basic research that are common to more than one Federal agency?

  --What is the appropriate Federal role in the development and use of human resources in science and technology?

- The Relationships Within the Science and Technology System

  --What relationships should the Federal Government foster with and among different research performers in the United States?

  --How can Federal, State, and local governments interact to promote the effective use of science and technology to address problems of national scope?

  --What role should the United States play in the world science and technology community?

- The Application and Diffusion of Science and Technology

  --How can Federal policies improve the climate for innovations that will foster economic growth and improve the quality of life?

  --What is the Federal Government's role in the application of social and behavioral science to innovation in the private sector?

  --How can the Federal Government improve the accessibility of science and technology information?

CHAPTER 3

THE ORGANIZATION AND PROCESS OF SCIENCE AND TECHNOLOGY POLICYMAKING

Successful policymaking in any field requires an effective organization and process for setting goals and objectives and for designing programs to achieve them. Designing effective programs depends upon receiving adequate information on the operation of actual and potential programs. This area-of-concern focuses on the development of those organizational arrangements and procedures which will improve the effectiveness of Federal science policymaking by providing the information needed to design and choose among science and technology programs.

We are proposing three LOEs within this area-of-concern:

- What can be done to improve the information provided to Congress to support decisionmaking on R&D priorities?
- How should long-range planning for science and technology be carried out?
- How should the Federal Government be organized for science and technology policymaking?

Two LOEs deal with the information and processes that are involved in science policymaking, and one LOE focuses on the organizational apparatus for science and technology policy.

LOE: WHAT CAN BE DONE TO IMPROVE THE INFORMATION PROVIDED TO CONGRESS TO SUPPORT DECISIONMAKING ON R&D PRIORITIES?

As the emphasis on using science and technology to achieve important national objectives in such areas as energy, economic vitality, health, and environmental quality increases, the need for R&D becomes greater. At the same time, however, the growing demand to reduce Government spending is causing the agencies responsible for Federal R&D to place increasing demands on scarce financial resources. In addition, R&D now represents 22 percent of that portion of the total annual budget which is considered "controllable." This makes it highly vulnerable to competing pressures for support of other Federal programs. Finally, R&D is an extremely complex and decentralized process involving both agency missions and interagency programs. Thus, careful attention must be given to effective decisionmaking for R&D.

Congressional concerns over R&D decisionmaking are often expressed by the need for more timely and useful Government-wide budgetary information. Specifically, Congress has expressed concern about the need for timely information which will allow them to make complex priority and trade-off decisions on R&D. For example, members of the House Committee on Science and Technology, because of the Committee's special oversight function, have continually voiced a need for better and more timely information. Representatives Don Fuqua, Beryl Anthony, Jr., and others supporting the passage of the Research and Development Authorizations Estimate Act (H.R. 7689) expressed concern that the congressional budget process as a whole, and the authorization process in particular, has grown in size and complexity. As a result, they need more timely and useful information which is coordinated with budget estimates to help them adapt to recent changes in the congressional budget process.

Comptroller General Staats has expressed similar concerns to Congress on numerous occasions over the past several years. Specifically, he has noted the following problems with the R&D budget process: (1) it does not address cross-cutting issues of Federal R&D science policy, (2) it does not provide sufficient information to enable Congress to examine interagency programs, and (3) it does not provide adequate program descriptions or adequate explanations of the rationales used for justifying agency priorities that are reflected in budget submissions. Furthermore, Mr. Staats has often stated that Congress needs to receive adequate information "before the fact" so that the various committees are in a better position to make complex priority and trade-off decisions on the R&D portions of the Federal budget.

In two previous efforts (Mission Budgeting: Discussion and Illustration of the Concept in Research and Development Programs, PSAD-77-124, July 27, 1977, and Need for a Government-wide Budget Classification Structure for Research and Development Information, PAD-77-14, March 3, 1977), GAO has examined the current budgetary process for federally funded R&D. These reports recommended changes in the way that agencies structure their budget submissions for R&D to the Congress. The first developed the mission budgeting concept for carrying out congressional review, authorization, and appropriations functions as an alternative approach to traditional agency funding requests. The latter proposed the unified presentation of all Federal R&D funding in a Government-wide budget classification structure which would indicate the amount of Federal funds each agency commits to specific national objectives.

The effort proposed in this LOE will be concerned with specifically identifying congressional information needs, analyzing current information aimed at addressing these needs, identifying what specific needs are not being met, and developing alternative ways for the Congress to have these information needs met.

Objectives

The primary objective of this LOE is to identify ways of improving the information provided to Congress to support its role in setting priorities and making trade-offs in the congressional budget process for Federal R&D. In order to accomplish this objective, several major questions must be addressed. They are:

- What kinds of information does Congress need to make better priority and trade-off decisions among Government-wide R&D programs?
- How adequate is the R&D budget information that is currently provided to Congress for interagency comparisons and related cross-cutting issues?
- What improvements need to be made in the R&D budget information provided to Congress? How should they be made? Who should make them?

Ongoing assignment

--An assessment of the information currently provided to the House Committee on Science and Technology (as a principal representative of congressional committees concerned with cross-cutting R&D budget issues) for use in cross-agency R&D budget decisions, and an identification of ways for improving that information (PAD-974179).

LOE: HOW SHOULD LONG-RANGE PLANNING FOR SCIENCE AND TECHNOLOGY BE CARRIED OUT?

Congress is becoming increasingly concerned with the need for long-range planning for science and technology. The Subcommittee on Science, Research, and Technology of the House Committee on Science and Technology held hearings this summer on long-term planning for national science policy at which the Comptroller General testified. These hearings were a sequel to the hearings which led to the 1976 National Science and Technology Policy, Organization, and Priorities Act. That act required that the executive branch carry out several exercises in long-term planning for science and technology.

However, as Congressman George E. Brown, Jr., has pointed out, those exercises have not resulted in the development of "an established and effective system of planning for science and its utilization." As the demands upon science and technology grow, both in terms of producing more benefits and in terms of imposing fewer societal costs, demands for more extensive long-range planning seem likely to grow.

One specific aspect of long-range planning which has attracted congressional attention has been the use of risk assessment as an approach to evaluating the effects of various products and technologies. Representative Don Ritter, for example, has introduced a bill (H.R. 4939) to promote the use of risk assessment in the Federal Government. The creation of OTA in 1972 also reflects this specific concern for evaluating the impacts of particular technologies.

There are three major components to any planning process. First, there must be an identification of the goals which policy is expected to achieve, or toward which it is directed. The need to set goals raises the issue of how goals are to be established. For example, what role should the public play in setting these goals? Should the public take part directly in setting goals by participating in public hearings and sitting on councils? Should detailed goals be established in legislation, or should these operational goals be left to be formulated by executive agencies? What balance should there be between the roles of the lay public and professionally trained experts in the setting of goals? If the public is to take part in a more direct form, is its understanding of scientific and technological issues adequate to play an effective role? If public understanding is lacking, what role should the Federal Government play in improving that understanding? If the public is to be represented directly, how should different constituencies within the public be weighted in representation at hearings, on councils, etc.? The issue of public participation includes the participation both of consumer and "public interest" groups, who are likely to be affected by safety and environmental effects of new technology, and of industrial and labor groups, who are likely to be affected in a more direct economic way by Federal planning decisions. What costs are associated with such a direct participation process in terms of delays in the policymaking process?

The second component of any planning process is an effort to forecast future developments, to estimate both what the state-of-the-future will be in the absence of any change in existing policy, and what effects potential policy changes will have on these existing trends. Forecasting the future is obviously an uncertain business, and it is not clear

whether a formal planning process is likely to generate forecasts which are any better than what informed "professional judgment" would produce. This is particularly true for science and technology, whose history is replete with examples of confident forecasts of the impact of technology which were wildly inaccurate. A major issue in discussions of long-range planning is, therefore, whether a formal planning process is likely to be more accurate in its forecasts than informal "professional judgment."

The third component of any planning process is the development of strategies designed to achieve our goals, given our forecasts of the effects of various policy actions (including no action at all). The effective development of strategies requires careful consideration of the mutual impacts which various policy initiatives have upon one another. One issue in Federal strategic planning, then, is whether planning should take place in some central agency which can consider these interaction effects, or in operating agencies where knowledge of the impacts of alternative strategies may be more exact. In many cases, selection of strategies also requires that goals which are expressed in vague, general terms must be reexpressed in operational terms. Usually the risks associated with different strategies will vary, and the planner must make some assessment of society's goals with respect to risk, which are rarely expressed in any explicit form.

Objectives

Our general objective for this LOE is to identify the issues raised by recommendations to expand long-range planning for science and technology, and to clarify the implications of these issues for Congress. Specifically, we seek to address the following questions:

- How is long-range planning for science and technology currently being conducted in the Federal Government? What are the problems and issues associated with these activities?

- What functions should be included in a long-range planning process for science and technology?

- How formal should the process of long-range planning be, given the difficulty of making forecasts of the future which are significantly better than informal "professional judgment"?

- Where should the planning process for science and technology be located? What should be the balance

between planning by a centralized White House office and planning by decentralized operating agencies? What should the respective roles of the Congress and the executive branch be in planning for science and technology?

- What role should risk assessment play in long-range planning for science and technology?

- What role should public participation play in setting goals for the science and technology planning process, and what role should the Federal Government play in promoting improved public understanding of science and technology for purposes of making this public participation more effective?

LOE: HOW SHOULD THE FEDERAL GOVERNMENT BE ORGANIZED FOR SCIENCE AND TECHNOLOGY POLICYMAKING?

Upon its establishment in 1950, one of the initial responsibilities of NSF was to coordinate Federal policy for basic research. This covered the basic research supported by all Federal departments and agencies. Although the National Science Board (NSB)--NSF's Board of Directors--identified problems and, in many respects, spoke for the Nation's scientists, the small NSF never felt comfortable or took responsibility for policies pertaining to research in other, larger Federal agencies.

The formation of the Office of Science and Technology (OST) in the Executive Office of the President in 1962 provided an opportunity to transfer this policymaking responsibility to an office which ranked above the Federal agencies. Assisted by a Federal coordinating council, OST (and OSTP, the current version established by legislation in 1976) has been responsible for Federal policy for basic research to the present. Except for a brief period in the early 1970s, all subsequent proposed organizational changes have kept OSTP in the White House as a part of the policy structure.

During the past three decades, sporadic proposals have been made to create a Department of Science and Technology by uniting various combinations of NSF, NBS, the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration, and offices charged with energy research. The Secretary of this department would be given a major operating responsibility for basic research in the Federal Government. It was felt that OST/OSTP, as the President's staff, cannot effectively advocate basic science policies--but a department with a Cabinet Secretary could be a strong proponent. No action has occurred on this proposal

except for several studies. Most recently, in the 1976 legislation creating OSTP, a President's Committee on Science and Technology (PCST) was established to study the entire range of issues dealing with the Federal management and organization of science and technology. PCST was abolished and the broad study was never completed. However, OSTP completed a study in 1980 which weighed the merits of a proposed Department of Science and Technology.

During the 96th Congress, Congressman Brown introduced legislation proposing the formation of a National Technology Foundation in response to a perceived lag in U.S. technological innovation. This organization would centralize Federal technology policymaking and consolidate various units of DOC and NSF. From DOC would come: the Patent and Trademark Office, the National Technical Information Service, and NBS; and from NSF: the Office of Small Business R&D and the Directorate of Engineering and Applied Science. Brown believes that perhaps OSTP, DOC, and NSF do not adequately deal with innovation policy and the legislation was introduced to stimulate discussion of the need for organizational change. Hearings were held on this bill in September 1980.

Objectives

The principal objective of this LOE is to identify and assess proposals for organizational change in the Federal structure for science and technology. As the complexity of science and technology issues continues to increase, we can expect more proposals for institutional change. Assessing the merit of these proposals requires consideration of questions such as:

- Would the proposed change consolidate policymaking responsibilities?
- Are the changes based on reported deficiencies? Are these deficiencies real? Would the proposed change cope with deficiencies?
- Does it make sense to combine the units proposed in a change? Are their functions compatible? Would the combination make them more effective on the whole?
- Would the reorganization bring the performers and the users of science and technology closer together or move them further apart?
- What negative impacts on existing departments and agencies might result from removing elements and reassigning them?

CHAPTER 4

THE SCIENCE AND TECHNOLOGY RESOURCE BASE

Appropriate science and technology resources must be available if the goals and objectives of science and technology are to be achieved. This area-of-concern addresses the development and maintenance of an accessible resource base, consisting of knowledge, human resources, R&D facilities, equipment, and institutions, which will be appropriate for future science and technology needs.

We have developed three LOEs in this area:

- How can NSF basic research policies and programs ensure appropriate balance among scientific accountability, financial accountability, and administrative effectiveness?
- What can be done to address issues concerning the administration of basic research that are common to more than one Federal agency?
- What is the appropriate Federal role in developing and maintaining human resources for science and technology?

In view of the substantial overlap in the issues addressed by the first two LOEs, we have combined much of the background for these two LOEs into a single discussion. The specific issues and objectives for the two LOEs are separated within that discussion.

LOE: HOW CAN NSF BASIC RESEARCH POLICIES AND PROGRAMS ENSURE APPROPRIATE BALANCE AMONG SCIENTIFIC ACCOUNTABILITY, FINANCIAL ACCOUNTABILITY, AND ADMINISTRATIVE EFFECTIVENESS?

LOE: WHAT CAN BE DONE TO ADDRESS ISSUES CONDERNING THE ADMINISTRATION OF BASIC RESEARCH THAT ARE COMMON TO MORE THAN ONE FEDERAL AGENCY?

BASIC RESEARCH ISSUES COMMON TO THESE LOEs

In these LOEs, we intend to address policy and management issues related to the development and maintenance of fundamental knowledge. Such knowledge is developed through the conduct of basic research. This type of research can be described as a systematic, intensive study directed toward greater understanding of a subject without regard for potential application. As part of the Nation's science and technology resource base,

scientific knowledge is essential to the continued growth of the national economy and to the resolution of important national concerns in areas such as health, environment, energy, and natural resources.

The Federal Government has accepted the primary responsibility for funding such research across a broad range of scientific disciplines. NSF has estimated that the Federal Government will support about 54 percent, or $9.1 billion, of all U.S. basic research in 1981. There are two reasons why the Federal Government supports such research. First, various mission agencies support basic research to acquire fuller knowledge or understanding over the long term in order to achieve their specific practical goals (e.g., Department of Defense support of solid-state physics or materials research and Department of Energy support for fundamental studies of subatomic particles). Second, NSF supports basic research to foster the development of basic knowledge, but its support is not linked to accomplishment of a specific national mission.

Since certain issues related to basic research are cross-cutting in nature and are of concern to all Federal agencies which support basic research, we have established two LOEs which will allow us comprehensively to examine such issues.

In the first LOE, we plan to focus on NSF, the Federal Government's lead agency for support of "nondirected" basic research, and its organization for and administration of basic research programs. In light of NSF's unique mission in basic research, we believe that a separate LOE which will allow us to better focus our attention on issues specific to NSF will allow us to provide the appropriate support for congressional oversight of NSF.

In the second LOE, we plan to compare and contrast different Federal agencies which support basic research in order to learn more about how generic issues in research administration (e.g., the need for scientific and financial accountability for research funds) are addressed in different agencies. This approach will allow us to draw informed conclusions about the generalizability of different approaches and to recommend ways in which Federal agencies can work more closely together and/or draw on the experience of one another to ensure that programs supporting basic research are well managed.

While the goals of NSF and the mission agencies differ, the issues that are raised in the support of basic research whether for its own sake or for the sake of an agency mission are quite similar. It is, therefore, appropriate to discuss jointly these common issues of basic research, accountability, and administration.

The first major issue in the support of basic research is the problem of appropriately defining accountability in the use of public funds. Basic research is intrinsically uncertain. A researcher can plan neither what he will discover nor the most fruitful course of research to pursue. If our definition of accountability rigidly requires researchers to carry out their research according to a detailed prearranged plan, then meeting the accountability criteria would often prevent researchers from realizing the maximum return on the Nation's investment in basic research.

Clearly, however, standards of accountability are needed. Agencies supporting basic research must ensure that the funds are spent for the purposes for which that support was intended. This need for accountability takes two forms. "Financial" accountability refers to the need to ensure that funds are spent prudently for the purposes for which they were granted, and not to support personal or institutional objectives unrelated to that purpose. "Scientific" accountability refers to the degree to which funds are spent in a way which is acceptable to the norms of the scientific community--ensuring that the research is carried out in a way that conforms to scientific standards, and ensuring that funds are allocated in a way which reflects the scientific merit of the various applications for funds. The researcher must be accountable both to the funding agency and to the scientific community.

The primary mechanism for ensuring scientific accountability is the peer review system, which has been a fundamental feature of NSF and many other Federal basic research programs from their inception. In ensuring that the peer review system is operating properly, we must raise a number of questions. Are the "peers" familiar enough with the area in which the researcher is doing work to judge his research? Are there conflicts of interest which prevent the peer review system from working properly? Does the "old boys' network" result in favoritism in the grant award process? Are peer judgments based on valid measures of scientific quality? Are they, for example, unjustifiably biased against researchers who have published negative results which many believe make an important contribution to research? Does the review process, both within the funding agency and among outside reviewers, favor only "safe" research projects carried out within an established paradigm, and exclude riskier, more innovative studies? Such a charge was made last year before the House Subcommittee on Science, Research, and Technology of the House Committee on Science and Technology by the 1978 winner of NSF's prestigious Alan T. Waterman Award. Do basic research programs need to provide more "seed money" for the early stages of such innovative research?

The issues of financial accountability primarily involve the balance between the need of the funding agency to ensure that the funds are being spent prudently for purposes related to the grant, and the need of the researcher to spend his time doing research rather than preparing detailed proposals and financial reports. The researcher's expertise is in doing research, not in preparing financial plans and reports; to the extent that the researcher's time is spent doing work not directly contributing to his research, the productivity of the research program may be reduced. Financial accountability also involves the issue of the balance between requiring the researcher to carry out his research according to his stated plan, and the need for flexibility to respond to interim discoveries of his research. This latter issue also involves scientific accountability, because, if the researcher is given flexibility in redirecting his research as it proceeds, he is exempted from the oversight of the scientific peers who approved his research project when the grant was made. Purely financial accountability issues include issues like the treatment of overhead expenses, proper accounting for time spent jointly on research and teaching, etc. Among the issues involving both financial and scientific accountability are, what constitutes a change in the "scope of work" which necessitates approval from the funding agency (and peer review)? How specific should be the objectives which the researcher is required to achieve? What is an acceptable way to ensure that the researcher spends the agreed-upon time on the project?

Finally, there are important issues to be addressed in the management of Federal laboratories, research centers, and programs. These issues partly involve the same issues of financial and scientific accountability, but also involve more traditional issues of efficiency and effectiveness. While the scientific community often feels at odds with Federal research administrators on issues of accountability, there need be no conflict on issues of efficiency and effectiveness. The more efficiently research funds are spent, the more research scientists will be able to do within a given budget. An important issue in research administration, however, is how "efficiency" should be defined in the performance of basic research.

ISSUES AND OBJECTIVES FOR THE FIRST LOE

The issues addressed by this LOE revolve around the questions of scientific and financial accountability and administrative effectiveness discussed above. NSF has a number of innovative programs under way which raise these issues in a more specific context. For example, in January 1980, NSF established an experimental mechanism which allows program

officers to recommend 2-year extensions of grants made to the most creative scientists in order to increase opportunities to attack adventurous, "high-risk" research questions. This program, established on a 3-year experimental basis, increases the amount of flexibility available to the researcher, but reduces the amount of oversight by the program officer and by the scientist's peers. It thus raises issues of scientific and financial accountability.

Similar issues are raised by NSF's Master Grant Program, an experimental program which groups together grants made to an academic department in a particular university. This program is intended to simplify the university grant administration and increase flexibility, but may increase the difficulty in allocating responsibility for grant administration. Additional issues of efficient and effective management are raised by the NSF's National Research Centers and by such major research programs as the Ocean Margin Drilling Program.

Objectives

The general objective of this LOE is to determine if NSF is making the best possible contribution, given its resources, to the Nation's basic research effort. Specifically, we need to answer the following questions:

- How do NSF policies currently encourage or hamper the pursuit of basic research?
- What level of scientific accountability exists in the NSF basic research system?
- Are there alternatives to the present administration of NSF basic research grants which are acceptable and workable for both NSF and the performers of the research?
- What degree of management control is being exercised over NSF basic research programs?
- How effective are the mechanisms used by NSF to ensure that innovative research proposals are funded?

Ongoing assignments

--A review of the effectiveness of NSF's policies and procedures in minimizing conflicts of interest in its grant award process (PAD-920862).

--A follow-up review of the effect of recent NSF attempts to improve the handling of peer reviewer comments in the grant award process (PAD-920864).

--A review of the NSF experimental Master Grant Program (PAD-920865).

--A review of NSF's National Research Centers (PAD-920866).

--A review of NSF's awarding of oceanographic research vessels (PAD-920867).

ISSUES AND OBJECTIVES FOR THE SECOND LOE

The issues of scientific and financial accountability in basic research are especially acute in mission agencies where basic research is expected to contribute to the achievement of the agency's mission. It is extremely difficult to determine what contribution a basic research project is likely to make to an agency's mission, and yet congressional mandates require that basic research carried out by mission agencies have some such potential impact. It is an issue which is generic to all Federal agencies which support basic research.

Mission agencies also face difficult issues in planning and administering basic research programs in ways which have a maximum impact on their agency mission. Effective management of basic research involves deciding what fields of basic research are most likely to contribute to the agency's mission, and making difficult trade-offs in spending within a program, such as trade-offs between improving experimental equipment and making adequate use of equipment already available.

Objectives

Our objective for this LOE is to determine what policies of general applicability to agencies which support basic research would make that support more effective and appropriate. Specifically, we need to address the following questions:

- How do research policies of Federal agencies encourage or hamper the pursuit of basic research?

- How are the concepts of scientific and financial accountability defined in research administration?

- What are the advantages and disadvantages of the current application of the concepts of scientific and financial accountability to the process of

research grant administration by university and Government officials?

- How can the level of scientific accountability which exists in the Federal basic research system be determined?

- How can Federal agencies determine an appropriate scale and focus for basic research programs?

- How effective are the mechanisms used by Federal agencies to ensure that innovative research proposals are funded?

Ongoing assignment

--A review of the Federal research grant funding process at NSF and the National Institutes of Health which evaluates the performance of peer review and the agencies' monitoring and evaluation systems (PAD-971450).

LOE: WHAT IS THE APPROPRIATE FEDERAL ROLE IN DEVELOPING AND MAINTAINING HUMAN RESOURCES FOR SCIENCE AND TECHNOLOGY?

Educators and Government officials conceive of science education as a mechanism linking human resources with national scientific and technological endeavors. Government involvement in science education was historically based on a desire to develop and maintain a supply of well-trained people as resources for those national purposes utilizing science and technology. The Science Education Directorate of NSF, the agency charged with lead responsibility in science education, was organized with a scientific and technological manpower objective in 1950. After the 1957 Sputnik scare, Federal funding of science education was substantially increased. The Federal effort was designed to identify talented people and promote their success in scientific and technological careers, as a means to strengthen national capability and maintain world leadership in science and technology.

The NSF science education effort has taken a variety of approaches. For example, programs have ranged from direct student support (e.g., fellowships and traineeships), to the upgrading of teacher competency (e.g., teacher institutes), to curriculum development (e.g., methods and materials improvement). Program targets have included students, teachers, institutions, and school systems at all educational levels (e.g., pre-college, college, graduate, and post-doctoral).

With the advent of an oversupply of scientists and engineers in the late 1960s, it became clear that the objective of ensuring an adequate supply of scientists and engineers was no longer supportable. The manpower oversupply, coupled with pressures for reducing NSF's emphasis on science education by NSB and the Office of Management and Budget (OMB), led to a decrease in science education funds. The infrastructure for Federal science education activities remained, however. Gradually, the direction and objectives of Federal science education efforts changed.

Today, the Federal role in science education has multiple objectives and involves more than one agency. In addition to the traditional objective of training scientific and technical personnel, Federal science education programs now seek to promote science literacy, public understanding of science and technology, ethics and values in science and technology, and equal access for women, minorities, and handicapped to science and technology education and employment. Science education programs are now undertaken by the Departments of Agriculture, Defense, Education, and Energy, as well as by NSF.

Congressional interest and enthusiasm for science education has been constant throughout. Congressional committees have mandated increases (contrary to NSB and OMB pressures) in science education budgets, have taken an active lead in establishing program directions, and have supported science education activities implemented in other agencies.

Currently, there is considerable attention being given to the "health" of science education. The President requested a major executive review on the state of science education. The National Research Council (NRC) is also conducting a review of science education. The following factors form the bases for this attention:

--Reports that increasing financial pressures hamper science education development on all levels from implementing new programs to hiring faculty and purchasing materials.

--Claims that decreasing student populations and school revenues are threatening science and mathematics teaching cutbacks, programs normally considered less important at the pre-college level.

--Reports of declining student interest in science and mathematics.

--Warnings from educators and industrialists that obsolete materials and equipment in schools are contributing to lowering the quality of engineering education.

--Criticism that science education is not preparing the nonscientist to make decisions necessary for life in a technological culture.

--Studies that call for a flexible scientific and technological workforce, conflicting with other studies suggesting an oversupply of technically trained manpower.

Objectives

Our primary objective in this LOE is to identify and clarify major issues in Federal science education policy in order to aid Congress in future planning and decisionmaking for science education. We propose to achieve this objective by addressing the following questions:

- What are the objectives of the Federal role in science education?
- What is the nature of the current Federal involvement in science education (e.g., what objectives are being addressed, how are they being addressed, and to what extent)?
- What are the consequences and implications of current Federal involvement in science education (e.g., gaps, lack of coordination)?
- What needs to be done to improve science education in the United States?
- What is the appropriate Federal role in science education?
- How should Federal science education activities be organized?

Ongoing assignment

--Development of a framework for analyzing Federal policies for science education (PAD-974176).

CHAPTER 5

THE RELATIONSHIPS WITHIN THE SCIENCE AND TECHNOLOGY SYSTEM

Researchers and other actors engaged in science and technology are distributed among Government, industry, and universities; among different levels of government; and among the world's nations. Maintaining and improving effective working relationships among these actors is vital to effective policymaking and to effective development and application of science and technology resources.

This area-of-concern addresses the question of the proper Federal role in fostering effective working relationships in this area. The LOEs which follow address the three dimensions of the issues mentioned above--the Federal Government's relationships with the private sector (i.e., universities and industry); with other levels of government; and with other nations.

- What relationships should the Federal Government foster with and among different research performers in the United States?
- How can Federal, State, and local governments interact to promote the effective use of science and technology to address problems of national scope?
- What role should the United States play in the world science and technology community?

LOE: WHAT RELATIONSHIPS SHOULD THE FEDERAL GOVERNMENT FOSTER WITH AND AMONG DIFFERENT RESEARCH PERFORMERS IN THE UNITED STATES?

Two assumptions currently appear to govern the Federal Government's relationships with the Nation's research performers (i.e., universities, industrial firms, research institutes, Federal laboratories, and federally funded R&D centers). The first assumption, expressed in the 1976 National Science and Technology Policy, Organization, and Priorities Act, is that a "solid base for science and technology" is best assured through maintaining and strengthening the "diversified scientific and technological capabilities" of the Nation's research performers. The second assumption, stated by President Carter in his 1979 Science and Technology Message to Congress, carries the first assumption a step further. While the Government must recognize the value of the "distinct goals and objectives and special institutional qualities" of different research performers, it must "harness"

their unique capabilities through policies and programs which emphasize "partnerships" and "linkages" between the Government and individual research performers and among research performers.

At present, two specific relationships within this general policy area are leading topics for policy concern. The first relationship is between Government and one type of research performer--the Nation's universities. Since January 1980, several study groups have issued reports with recommendations for reassessing the nature of the Government/university "partnership." The second relationship is between two types of research performers--universities and industry. This relationship is currently the focus of attention by policymakers in both the legislative and executive branches. In the past legislative session, eight bills were introduced by Congress which would enhance the Federal capacity to "harness" the resources of universities and industry to meet national ends. In the executive branch, several agencies are beginning to implement programs which would strengthen research ties between the two sectors.

Objectives

The objective of this LOE is to determine the appropriate Federal role in relationships with and among research performers. Future work in this LOE should answer the following questions:

- What are the unique characteristics of each research performer and how do these influence the conduct of scientific inquiry? What criteria should the Government employ to determine what research should be supported at different kinds of institutions?

- In designing policies, what balance should the Government strike between attempting to preserve the unique characteristics of each research performer, and changing such characteristics in order to make research performers more responsive to national needs?

- Given the different goals, objectives, and constraints of each research performer, in what areas does the Government need further to adapt and tailor its policies (e.g., regulations) for specific performers to enhance and not detract from the performance of research?

- What role should the Government play in strengthening relationships between different research performers?

Ongoing assignment

--Alternative Government roles in stimulating university-industry collaboration in research (PAD-974174).

LOE: HOW CAN FEDERAL, STATE AND LOCAL GOVERNMENTS INTERACT TO PROMOTE THE EFFECTIVE USE OF SCIENCE AND TECHNOLOGY TO ADDRESS PROBLEMS OF NATIONAL SCOPE?

There is an increasing need for Federal, State and local governments to work together to resolve far-reaching national problems. There are several reasons for this. First, national problems in such areas as transportation, energy, and law enforcement have become increasingly pervasive, and attempts to remedy these problems through the use of science and technology have become so technically complex that they range beyond the capabilities of any one level of government. Second, many of these problems involve multiple jurisdictions which must cooperate both to define the problem and to implement a solution. Third, all levels of government are under intense pressures to increase efficiency and reduce duplication of effort. Finally, there is a continuing concern that the results of the billions of dollars invested in federally sponsored science and technology be applied to solving national problems at all levels of government. All of these pressures point to the need for Federal, State, and local governments to form partnerships to define problems and to make good use of science and technology to solve them.

Intergovernmental relationships in science and technology have been the focus of considerable interest in the Executive Office of the President, many Federal executive departments and agencies, the Congress, and State and local organizations for many years. Federal involvement in intergovernmental science issues was codified with the passage of the State Technical Services Act in 1965 and the Intergovernmental Cooperation Act in 1968. In 1970, the House Committee on Science and Astronautics recommended that "the scientific method and technological research should be increasingly utilized by regional, State, and local organizations in seeking solutions to societal problems." In 1971, the White House Domestic Council, at the direction of President Nixon, initiated the New Technological Opportunities Program to examine Federal involvement in support of nondefense R&D. President Nixon greatly acknowledged the benefits to be derived from the effective use of technological resources by State and

local governments in a Message to Congress on Science and Technology in March of 1972.

A major development in the area of intergovernmental science relationships was the creation of the Intergovernmental Science, Engineering, and Technology Advisory Panel (ISETAP), established by the National Science and Technology Policy, Organization, and Priorities Act of 1976. ISETAP was mandated to identify and promote Federal programs to increase State and local utilization of federally funded R&D. Other important Federal executive activities in the area of intergovernmental science include the Federal Laboratory Consortium for Technology Transfer and NSF's Intergovernmental Science and Public Technology (ISPT) Program. More recently, President Carter, in his 1979 Science and Technology Message to Congress, described improvement in Federal, State, and local relationships in science and technology as an integral part of a strategy to manage and ensure the vitality of the science and technology enterprise.

Congress' recent and continuing interest in intergovernmental relations in science and technology was indicated by a series of four hearings in March-September 1979 which focused on issues concerning the use of Federal laboratories, State and local science and technology assistance programs, and ISETAP. During the next legislative session, Congress will continue to explore ways of using Federal R&D resources to meet the needs of State and local governments. This congressional concern was directly addressed by the proposed Governmental Efficiency in Research and Development Act of 1980 and by the intergovernmental provisions of the National Technology Innovation Act, both of which will be considered in the 97th Congress. In addition to these two pieces of legislation, Congress will consider initiatives to help State and local governments build capacity for developing and implementing programs to meet national policy objectives, such as in the area of energy policy.

Past GAO interest in this policy area has focused on how the Federal Government can best transfer technology through the intergovernmental system. In 1972, GAO studied how defense-related technology and technical expertise could be used to meet and solve problems in the civilian sector. A 1975 GAO study 1/ of the NASA/NSF jointly funded "Four Cities Program" in California identified conditions necessary for successful intergovernmental technology transfer.

1/"Technology Transfer and Innovation Can Help Cities Identify Problems and Solutions," PSAD-75-110, August 6, 1975.

At present, activities to promote intergovernmental relationships in science and technology are being pursued which have three major emphases:

--The role of State and local governments in setting Federal science and technology R&D agendas.

--Ways of increasing the utilization of federally sponsored science and technology and R&D by State and local governments.

--Federal assistance to State and local governments to help them build their capacity to use science and technology.

All of these emphases are potentially complementary; however, they have frequently been implemented in ways that have resulted in conflict (e.g., when the pressure to use federally sponsored R&D overrides non-Federal judgments about what is actually needed to solve State and local problems). In addition, which level of government should play what role in developing and maintaining relationships is not clearly defined within these three areas of emphasis. As a result, the nature of the "partnerships" required to facilitate the identification of problems and the implementation of solutions is far from being clearly understood. Objectives, roles, and responsibilities of each level of government must be defined and agreed upon if these "partnerships" are to help to have impact on national problems.

Objectives

The primary objective of this LOE is to develop a broad understanding of the current status of and important issues surrounding intergovernmental science and technology. This understanding will provide us with information to determine the extent to which GAO might provide assistance to Congress in the policymaking process with regard to those relationships as they aid in solving pervasive national problems.

To accomplish this objective, the following questions must be addressed:

- What is the nature of existing intergovernmental relationships that are intended to influence the use use of science and technology in addressing pervasive national problems?

  --What relationships exist to involve State and local governments in setting Federal science and technology and R&D agendas?

--What efforts are being made to increase the utilization of federally sponsored science and technology and R&D by State and local governments?

--What activities are being undertaken by the Federal Government in helping State and local governments build capacity to use science and technology to address problems?

- What do the successes and failures of current and past programs tell us about the appropriate objectives, roles, and responsibilities which result in beneficial intergovernmental science relationships?

- What problems and issues which have important policy relevance emerge from examination of current and past intergovernmental relationships?

- What is the appropriate Federal role in designing and supporting intergovernmental science and technology relationships which are designed to help solve pervasive national problems?

LOE: WHAT ROLE SHOULD THE UNITED STATES PLAY IN THE WORLD SCIENCE AND TECHNOLOGY COMMUNITY?

Science and technology are widely used by the United States and other countries to help solve major national problems and achieve future goals and objectives. However, the efforts of almost all national governments to use science and technology to address national objectives influence--and are influenced by--the problems and objectives of other countries throughout the world.

Such problems and objectives are usually not restricted to national boundaries. We are becoming increasingly aware that issues like environmental quality and the supply of energy and natural resources affect many nations simultaneously. In these and other areas, science and technology can provide the means for solving both national and international problems through international cooperation and through the direct transfer of scientific information and technological processes from one country to another.

The members of the international science and technology community, including those countries and private industries possessing significant science and technology resources and capabilities, interact through a variety of mechanisms such as the United Nations; international conferences; exchanges of university faculty, students, and researchers; and

multilateral and bilateral trade and cooperative agreements. The United States must attempt to understand its role in this community in order to achieve specific national and international goals.

Today, effective participation in the international science and technology community depends upon an understanding of the roles of Federal actors in that community as well as their relationships to each other and to other countries. However, the responsibility within the Federal Government for supporting and promoting international cooperation in the coordination and use of science and technology resources is extremely diffused. Almost all Government agencies are active participants in the international science and technology community in their own mission areas (e.g., energy and health).

The Congress and the Comptroller General have shown increasing interest in these issues because of our vast scientific and technological capabilities as well as the potential of our role in the world science and technology community. The Congress has attempted to become informed in this area through the reporting requirements of the National Science and Technology Policy, Organization, and Priorities Act of 1976 (Public Law 94-282) and of various other legislative acts such as the International Security Assistance Act of 1977 (Public Law 95-92) and the Export Administration Amendments of 1977 (Public Law 95-52).

Congress has expressed the concern that existing analytical studies available on this subject are inadequate for judging either the extent of policy gaps and weaknesses or the success of current programs. The Comptroller General stated that the new Science and Technology Issue Area should (1) consider the impact of domestic science and technology policies on world interdependence, and (2) assess the position of the United States in the world science and technology environment. In addition, much of the work done by OSTP covers aspects of this LOE, and there is evidence that their focus on international issues will increase in the future. Other individual agencies, especially NSF and the Department of State, play lead roles in the international science community.

Objectives

The basic objective of this LOE is to provide Congress with a basis for better understanding how the United States fits into the world science and technology community and how effective participation in that community can create opportunities for the United States to achieve specific national and international goals.

In order to achieve this objective, several major questions must be addressed. They are:

- What should be the role of the Federal Government in relation to the roles of multinational corporations, nonprofit institutes, and universities in technology transfer to other nations?

- What is the position of the United States vis a vis other countries in terms of our science and technology resources and capabilities?

- How has our current participation in the world science and technology community affected our ability to meet important national needs?

- On the basis of growing world interdependence, what are the emerging national and international issues which will require effective U.S. participation in the world science and technology community?

- What is the appropriate U.S. role in strengthening the scientific and technological capacities of developing nations?

CHAPTER 6

THE APPLICATION AND DIFFUSION OF SCIENCE AND TECHNOLOGY

Knowledge in appropriate areas must be distributed and applied if science and technology is to be effectively used to address national needs. This area-of-concern focuses on making science and technology available to their ultimate users and ensuring their appropriate use.

The LOEs which follow address three aspects of this area-of-concern.

- How can Federal policies improve the climate for innovations that will foster economic growth and improve the quality of life?
- How can the Federal Government help to improve the application of social and behavioral science in the private sector?
- How can the Federal Government improve the accessibility of science and technology information?

LOE: HOW CAN FEDERAL POLICIES IMPROVE THE CLIMATE FOR INNOVATIONS THAT WILL FOSTER ECONOMIC GROWTH AND IMPROVE THE QUALITY OF LIFE?

Innovation is the commercial introduction of new products and processes of production. Innovation is important because it can lead to increases in output and improvements in the quality of life through, for example, improvements in manufacturing processes and in pollution control technologies. Innovation also plays an important role in national security and foreign policy.

A wide range of Federal policies influences both the general amount and the particular kinds of innovation which occur. Innovation is promoted directly by Federal support for research and development, by Federal support for science education, by Federal subsidies for the commercialization of new technology (e.g., in transportation and energy), and by the Federal patent system. Other Federal policies may either promote or retard innovation, or simply change its direction. Federal regulatory policies may prevent firms from developing technologies they want to develop, or force them to alter technologies or develop new technologies which they would not have developed on their own. The net effect may be either to encourage or to discourage innovation in general, but will certainly result in a change in its direction. Procurement

policies may either promote or retard innovation, depending upon the specifications which are established for the goods and services procured. Tax policies may encourage innovation by providing incentives both for private expenditures on R&D and for investments in capital equipment which embodies new technology. Innovation might be promoted by providing more incentives for innovative forms of compliance with regulations, by shifting procurement specifications from design specifications to performance specifications, and by providing tax incentives for investments in plant and equipment embodying new technology.

Over the past decade, concern has grown that the rate of innovation in the United States has declined. While there is no measure of innovation which might confirm such an impression, two prominent indicators which are related to innovation--patent rates and productivity growth rates--have both declined. Patent rates indicate the number of new inventions, including many which are never commercialized and thus never become innovations.

The terms productivity and innovation are frequently, but incorrectly, used interchangeably. Innovation and productivity are related, but only inasmuch as innovation is one of the many factors that influences productivity. Industrial innovation involves the commercial introduction and diffusion of new products and processes. Some of the new products will be used in other firms' production processes or in service industries; others will be consumer products which do not affect production processes. The only forms of innovation which affect productivity are the new processes and the products used in manufacturing processes and in services. Productivity is affected by many factors other than innovation. For example, the weather, the state-of-the-business cycle, the education and experience of the workforce, conditions in the workplace and labor motivation, economies of scale, crime, and Government regulation.

Concern for the rate of innovation has been expressed repeatedly in Congress, in the executive branch, by professional societies, and in the news media. Dozens of bills have been introduced to promote innovation. Hearings have been held by the Subcommittee on Science, Research, and Technology of the House Committee on Science and Technology, and by the Subcommittee on Science, Technology, and Space, of the Senate Committee on Commerce, Science, and Transportation, but the innovation issue has also drawn the attention of the House Committee on Ways and Means, the Senate Committee on Finance, the Joint Economic Committee, the House and Senate Committees on the Judiciary, and the House and Senate Committees on Small Business.

These concerns about innovation raise the following issues: Is there an "innovation problem"? What are the costs and benefits of policies designed to stimulate innovation? What resources are available to promote innovation? How effectively is Federal policy encouraging the use of those resources? In particular, how important are the resources available in small firms, and how effectively does Federal policy encourage their use? How extensive should the Federal role be in encouraging technological innovation? Should support for technology be across the board, or focussed in areas of perceived national need? How do we balance the desire for technological innovation against the need for environmental health, safety, tax equity, and social stability? Is an "industrial policy" necessary to promote innovation?

Objectives

Our general objective in this LOE is to analyze the "innovation problem" and the appropriateness of various proposals designed to address it. The reports which will be produced under this LOE will examine current Federal policy on innovation, discuss the shortcomings of that policy, and consider opportunities for improving that policy. Specifically, we seek to answer the following questions:

- What is the current impact of Federal policy on the rate and direction of innovation?
- What is the policymaking context within which Federal policies on innovation are made?
- What impacts do different kinds of innovation have on encouraging economic growth, improving the quality of life, and achieving other national goals?
- What major alternative approaches to creating an innovation policy exist, and what are their advantages and disadvantages? Would such policies have negative effects on achieving other national goals?
- What role should the Federal Government play in strengthening the role that small business firms play in innovation?
- What problems would arise in developing an "industrial policy" to encourage innovations which would help to achieve national goals?
- What policies to promote innovation exist abroad, and how appropriate are they to the American context?

- What effect would various proposals for patent reform have on the rate of innovation?

Ongoing assignments

--A framework for analyzing Federal policymaking on innovation (PAD-974175).

--A framework for analyzing the role of small business in innovation (PAD-974173).

LOE: WHAT IS THE FEDERAL GOVERNMENT'S ROLE IN THE APPLICATION OF SOCIAL AND BEHAVIORAL SCIENCE TO INNOVATION IN THE PRIVATE SECTOR?

As systematic approaches to the analysis, understanding, and prediction of human behavior, the social sciences offer a promising source of information for the solution of a wide variety of problems in the private sector, e.g., they may be used to improve productivity, innovation, communication, the quality of the work experience, quality control, etc. Unlike the physical and life sciences, however, where new and existing knowledge is routinely monitored for possible practical applications by industrial laboratories and the engineering profession, there exist few organizational or professional mechanisms in the social sciences whose major concern is the translation of basic knowledge into specific practical applications. As a result, the utilization of social science knowledge as a source of innovative solutions to practical problems in the private sector tends to be a somewhat haphazard and inefficient process, not unlike the relationship between the physical sciences and the inventor prior to the development of the industrial R&D laboratory in the early decades of the 20th century.

Past studies, such as the report of the Special Commission on the Social Sciences of NSB (Knowledge into Action: Improving the Nation's Use of the Social Sciences, 1969) and NRC's The Federal Investment in Knowledge of Social Problems (1978) have raised concern about the effectiveness with which the Nation's investment in the social and behavioral sciences is being used.

One area where increased application of the social and behavioral sciences could be beneficial is in the support of industrial innovation. Popular notions of innovation tend to focus on new "hardware" technologies, even though many of the technologies which are most effective in increasing productivity and achieving other goals are "software" technologies such as management techniques, quality control procedures, and shopfloor organization. As Chairman George E. Brown, Jr.,

of the Subcommittee on Science, Research, and Technology, House Committee on Science and Technology, noted, "Technology, in the sense I am using it, includes not only what comes immediately to mind--machinery, electronics, chemicals, and so forth--but also the structure and management of the human organizations of our society." Robert Cole, a University of Michigan sociologist, has compared the attitudes of Japanese and American managers towards the utility of social science in addressing problems of productivity and quality control. He has shown that Japanese managers are much more aware of and responsive to American social science than are U.S. managers and he argues that this contributes to Japanese superiority in these areas. This argument suggests that there are serious problems in the ways in which social and behavioral science knowledge is applied to private-sector problems in the United States.

Objectives

The primary objective of this LOE is to determine the appropriate Federal Government role in applying the Nation's stock of social and behavioral science to solving problems in the private sector, particularly when such problems are related to national needs and concerns. To accomplish this objective, the following questions need to be addressed:

- What are the mechanisms by which private industry and/or Government currently monitor and evaluate social and behavioral science for its potential applicability to problems in the private sector?

- What efforts does the Federal Government currently make to ensure that social and behavioral science knowledge is applied in the private sector to promote the attainment of national needs and objectives?

- How might the social and behavioral sciences be more effectively used to foster industrial innovation?

- How can we determine the nature and level of research support in the social and behavioral sciences that is needed to ensure effective application of knowledge to private sector problems? Is the Federal Government supporting enough of the kinds of research (e.g., interdisciplinary, problem-focused) that are likely to yield results useful to the private sector?

- How can social and behavioral science knowledge be effectively synthesized and disseminated? What is the Federal role?

- To what extent do the private-sector users of social and behavioral science knowledge influence the agenda for federally supported social and behavioral science research?

- What is the role of the Federal Government in gathering the statistical data necessary for social science research that can be applied to private-sector problems?

LOE: HOW CAN THE FEDERAL GOVERNMENT IMPROVE THE ACCESSIBILITY OF SCIENCE AND TECHNOLOGY INFORMATION?

Information science is the process of creating, organizing, disseminating, and using information. The explosive growth of scientific and technical information following World War II increased the complexity of problems already facing the information field. Scientific and technical literature is growing at such a rapid rate that there are those who believe the increasing volume of information will frustrate the very purpose for which it was created.

The response to this proliferation of scientific and technical information has been to increase information services and to refine information technologies. Data centers are being installed at an accelerating rate. Abstracting and indexing services are becoming increasingly sophisticated. Advances in information and telecommunication technology have led to growth of the "information" sector from one-quarter to one-half of the U.S. economy in the last three decades. These technologies are among the most rapidly changing technologies in use today. Thus, as more information is generated, more sophisticated mechanisms to store and retrieve this information are being developed. According to Chairman Brown, of the House Subcommittee on Science, Research, and Technology, we are rapidly acquiring the technical capacity to make a large portion of our information inaccessible. Because scientific and technical advances depend in large measure on the flow of useful information, a larger percentage of resources must be invested in improving the dissemination and application of scientific information.

Interest in addressing information problems is increasing, especially at the Federal level. This is indicated by the support for H.R. 6410, the "Paperwork Reduction Act of 1980," and an OMB draft circular dated June 3, 1980. Both address the broader area of information policy. The OMB

draft, originally intended to establish policy regarding the dissemination of federally financed scientific and technical information, requires The National Technical Information Service to maintain a central index of science and technology information which is available from the Federal Government. This is only a first step toward addressing information issues in general, and science and technology information problems in particular--more needs to be done. Little attention has been given to information generated outside the Government, or to the use of scientific and technical information to create new products, processes, and services and to improve the quality of life.

Objectives

Our objective in this LOE is to answer the following question: What should be the role of the Federal Government in improving access to science and technology information for all sectors of society? To accomplish this objective, the following specific questions need to be addressed:

- How is the Federal Government organized to promote the dissemination and application of scientific and technical information? How does the Federal Government relate to universities, private industry, and other research organizations in the dissemination and application of scientific and technical information?

- What are the problems with existing methods of making scientific and technical information available? Are some disciplines and sectors served better than others? Are users adequately informed about information technologies?

- What improvements are needed in existing scientific and technical information systems to make such information more accessible to users in all sectors? What is the appropriate Federal role in making these improvements?

- What are the costs, benefits, and risks of alternative approaches to making scientific and technical information more accessible?

MAJOR LEGISLATION RELATED TO SCIENCE POLICY

The following is a list of legislation introduced in the 96th Congress which directly pertains to or otherwise plays an important role in discussion of science and technology policy. Because the issue area is so broad, an effort has been made to exclude bills or public laws whose impact on science and technology does not constitute a major objective of the legislation. If a bill has passed either chamber, the results of the vote (whether roll call or voice vote) are indicated in parentheses.

SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Federal Organization for Science and Technology	H.R. 2640	3/6/79	Downey	Banking-Pending Rules-Pending Science and Technology-Pending	Creates the National Science and Technology Corp. to make and guarantee loans to promote basic and applied R&D. The NSTC would also assist the commercialization of Federally developed technologies.
	H.R. 6910	3/25/80	Brown	Judiciary-Pending	Establishes an independent agency, the National Technology Foundation, to promote technological innovation. Transfers to NTF: The Patent and Trademark Office, NTIS, NBS from Commerce and the Office of Small Business R&D, Directorate of Engineering and Applied Science from NSF.
	H.R. 8131	9/16/80	Ottinger	Banking-Pending Science and Technology-Pending	Establishes a National Industrial Innovation Corporation to provide loans, loan guarantees, and equity financing in joint ventures with private industry for innovative products, processes, or worker incentive programs.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Research and Development Programs	H.R. 4678	6/28/79	Harkin	5/6/80, Reported by Science and Technology 6/9/80, Reported by Interstate and Foreign Commerce 6/9/80, Placed on House calendar	Establishes a program within NASA to advance the state of automotive research and technology.
	H.R. 7689	4/28/80	Fuqua	7/21/80, Passed House (voice vote)	Seeks to provide additional information to Congress to provide a basis for implementing multiyear R&D authorizations. (Previously H.R. 4409 and H.R. 7178).
Patent Policy	S. 414	2/9/79	Bayh	4/23/80, Passed Senate (91-4)	Establishes a uniform Federal patent policy for small businesses and nonprofit organizations. Awards full title to federally funded inventions under certain conditions. Contains GAO provision.**
	S. 1215	5/22/79	Schmitt	Commerce-Pending Governmental Affairs-Pending	Similar to S. 414. Does not contain GAO provision.

**GAO provision:
If an agency withholds title, it must provide written justification to GAO within 30 days. GAO must monitor all such decisions and notify the agency should it determine that a pattern exists which violates congressional intent. Finally, GAO is required to report at least annually to the Congress on the implementation of this policy.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Patent Policy (cont.)	S. 2079	12/5/79	Bayh	Governmental Affairs-Pending Judiciary-Pending	Removes the Patent and Trademark Office from Commerce and establishes it as an independent agency.
	S. 2446	3/19/80	Bayh	3/20/80, Passed Senate (voice vote)	Provides for reexamination of patents to assess their impact on pending claims.
	H.R. 2414	2/26/79	Rodino	Judiciary-Pending markup	Identical to S. 414. Contains GAO provision.
	H.R. 3806	4/30/79	Rodino	Judiciary-Pending	Establishes a separate Federal Court of Appeals which would deal solely with patent issues.
	H.R. 5075	8/2/79	Butler	Judiciary-Pending	Identical to S. 2446 with the exception of the date of implementation.
	H.R. 5343	9/19/79	McDade	Judiciary-Pending	Similar to S. 414. Contains GAO provision.
	H.R. 5427	9/27/79	Ertel (by request)	Science and Technology-Pending	Identical to S. 1215.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Patent Policy (cont.)	H.R. 5607	10/16/79	Smith	5/16/80, Reported by Small Business (Title 1) Pending before Ways and Means (Title 2) Pending before Judiciary (Title 3)	(1) Establishes a Small Business Innovation Research (SBIR) program, whereby agencies having an R&D budget of specified size must set aside a set percentage for small small businesses. (2) Provides tax credits to small businesses for R&D expenditures. (3) Liberalizes patent policy towards small businesses. Contains GAO provision.
	H.R. 5715	10/26/79	Ertel	Judiciary-Pending Science and Technology-Pending	Similar to S. 414 but gives title to all Federal contractors, not just small busineses and nonprofit organizations. Does not contain GAO provision.
	H.R. 6533	2/19/80	Railsback	Judiciary-Pending	An omnibus patent bill which includes sections of S. 414, S. 2446, S. 2079. Contains GAO provision.
	H.R. 6933	3/26/80	Kastenmeier (by request)	Pending Judiciary markup session.	Sets Government patent policy concerning contract inventions, inventions of Federal employees, licensing of federally owned inventions. Does not contain GAO provision.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Patent Policy (cont.)	H.R. 6934	3/26/80	Kastenmeier	Judiciary-Pending	Allows computer software to be copyrighted.
	H.R. 6965	3/28/80	Ertel	Judiciary-Pending Science and Technology-Pending	Identical to H.R. 5715.
University/ Industry Relations	S. 1250	5/24/79	Stevenson	5/28/80, Passed Senate (voice vote) 7/2/80, Ordered reported by House Science and Technology Committee	Authorizes support of university/industry centers for development of industrial technologies.
	S. 1065	5/3/79	Danforth	Finance-Pending	Provides income tax credits to corporations for their contributions to universities performing basic research.
	H.R. 4672	6/28/79	Brown	Science and Technology-Pending	Identical to S. 1250.
	H.R. 5881	11/14/79	Vanik	Ways and Means-Pending	Equivalent to S. 1065.
Human Resources	S. 568	3/7/79	Kennedy	6/23/80, Passed Senate (voice vote)	Promotes the training and employment of women in science.
	H.R. 5305	9/17/79	Ottinger	Education and Labor-Pending Science and Technology-Pending	Equivalent to S. 568.
Small Business Innovation	S. 918	4/9/79	Nelson	Passed House & Senate but disagreement over Conference Report led to a new bill, S. 2698	Establishes small business development centers to provide management, technical, and technological assistance to small businesses.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Small Business Innovation (cont.)	S. 1074	5/3/79	Kennedy	Small Business-Pending	Establishes a SBIR program whereby agencies having an R&D budget of specified size must set aside a set percentage for small businesses.
	S. 1078	8/3/79	Percy	Governmental Affairs-Pending	Establishes SBIR program and an Office of Small Scale Technology within DOE to promote use of small scale technologies.
	S. 1860	10/9/79	Nelson	5/15/80, Reported by Small Business (Title 3 only) Finance-Pending (Title 3 only)	Title 3 of the original bill contains various tax breaks for small business, including credits for R&D expenditures.
	S. 2698	5/14/80	Nelson	5/28/80, Passed Senate (83-2) 6/3/80, Passed House (voice vote) 7/2/80, Signed by President	Identical to S. 918 with the exception of one provision concerning disaster relief which was dropped in S. 2698.
	S. 2749	5/21/80	Nelson	5/21/80, Reported by Small Business 5/21/80, Placed on Senate calendar	Establishes SBIR programs. (Original Title 1 of S. 1860.
	H.R. 90	1/15/79	Smith	Superseded by H.R. 4011	Identical to S. 918.
	H.R. 1308	1/23/79	Whitehurst	Superseded by H.R. 4011	Establishes a Small Business Development Center program to provide a broad range of assistance to small businesses.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Small Business Innovation (cont.)	H.R. 2909	3/14/79	Bouquard	Superseded by H.R. 4011	Similar to H.R. 1308.
	H.R. 4011	5/8/79	Smith	5/22/80, Passed House (398-5) 5/22/80, S. 4011 tabled in favor of S. 918	Establishes Small Business Development Centers to provide management development, technical information, product planning and international market development assistance to small businesses.
	H.R. 5126	8/2/79	Lewis	Small business-Pending	Establishes SBIR programs in agencies with specified R&D budgets.
	H.R. 5607	10/16/79	Smith	5/16/80, Reported by Small Business (Title 1) Pending before Ways and Means (Title 2) Pending before Judiciary (Title 3)	(1) Requires Federal agencies which conduct R&D of specified budget size to allocate a certain percentage to small businesses. (2) Provides tax credits to small businesses for R&D expenditures. (3) Liberalizes patent policy towards small businesses. Contains GAO provision (see page 2).
	H.R. 5702	10/25/79	Beard	Small Business-Pending	Seeks to increase the role of small businesses in federally funded R&D.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Tax Incentives for R&D	S. 700	3/21/79	Danforth	Finance-Pending	Provides investment tax credit for R&D expenditures.
	S. 1254	5/24/79	Bentsen	Finance-Pending	Provides for amortization of R&D expenditures in connection with a patent for up to 60 months.
	S. 1256	5/24/79	Bentsen	Finance-Pending	Allows income tax credit for certain R&D expenditures.
	S.1257	5/24/79	Bentsen	Finance-Pending	Combines provisions of S. 700 and S. 1254.
	H.R. 4405	6/11/79	LaFalce	Ways & Means-Pending	Equivalent to S. 1257.
	H.R. 4406	6/11/79	LaFalce	Ways & Means-Pending	Equivalent to S. 1256.
	H.R. 4407	6/11/79	LaFalce	Ways & Means-Pending	Equivalent to S. 1254.
	H.R. 4646	6/27/79	Jones	Ways & Means-Pending	Provides a system of accelerated capital cost recovery for investment in business facilities and equipment.
	H.R. 5313	9/18/79	LaFalce	Ways & Means-Pending	Liberalizes capital gains treatment of small businesses engaged in R&D.
	H.R. 5435	9/27/79	Regula	Ways & Means-Pending	Equivalent to S. 700.

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SUBJECT	BILL NUMBER	DATE OF INTRODUCTION	PRINCIPAL SPONSOR	COMMITTEE AND STATUS	ABSTRACT
Risk Assessment	H.R. 4939	7/24/79	Ritter	Science & Technology-Pending	Directs OSTP to establish a Federal mechanism to apply and promote the understanding and evaluation of comparative risks in science and technology policy.

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