REPORT OF THE COMMISSION ON GOVERNMENT PROCUREMENT

VOLUME 2

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DECEMBER 1972

COMMISSION ON GOVERNMENT PROCUREMENT

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December 31, 1972

The Honorable Spiro T. Agnew
President of the Senate
Washington, D. C.

and

The Honorable Carl B. Albert
Speaker of the House of
Representatives
Washington, D. C.

Gentlemen:

In accordance with the requirements of Public Law No. 129, Ninety-first Congress, as amended by Public Law No. 47, Ninety-second Congress, the Commission on Government Procurement submits herewith its report.

Respectfully yours,

E. Perkins McGuire

E. Perkins McGuire
Chairman

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REPORT OF

THE COMMISSION ON GOVERNMENT PROCUREMENT

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FOREWORD

Volume 2 consists of Part B (Acquisition of Research and Development) and Part C (Acquisition of Major Systems). Much of the subject matter in both parts is technology oriented and, in some cases, closely related and mutually supportive.

Reports of Commission Study Groups 1 (Utilization of Resources), 11 (Research and Development), and 12 (Major Systems Acquisition) were the sources of much of the background material considered in preparing this volume. Approximately half the members of each of these study groups were from the Government and the remainder were from the private sector. Each study group spent more than a year performing a comprehensive study of its assigned area.

Part B stresses the importance of a viable technology base, not only as a source for special applications, such as major systems, but as a mechanism to further national development and to foster the competitive position of the United States in areas of high technology. Part C stresses the importance of those key decisions that control the application of new technology to meet public needs through system acquisition programs. It stresses, as well, the kinds of information used in making such decisions and the roles and responsibilities of the organizations that make them.

Data in Part B indicate trends in research and development (R&D) funding generally; Part C treats specifically the R&D activity of the Department of Defense as it relates to major systems. Parts B and C analyze the roles of Government in-house laboratories and other R&D activities in the public and private sectors.

Both parts stress the need for freedom of innovation and maximum utilization of the science and technology capability of the private sector. Part B contains an in-depth analysis of independent research and development (IR&D), with major emphasis on the technology base; Part C considers IR&D as a mechanism for innovative system development, with particular emphasis on conceptual and early design studies.

Part B discusses the special nature of competition in R&D procurement; a major theme of Part C is that alternative system approaches should be pursued in competition at least from the early conceptual phase through the selection for final development.

In summary, Part B contains both procurement and national policy issues and recommendations. Its major theme is that the procurement process should maximize innovation in both the public and private sectors. Part C proposes a framework for the acquisition of major systems based on a model of the key decision points and the information needed at each point.

While each Commissioner does not necessarily agree with every aspect of this report, the Commission as a whole is in agreement with the general thrust of the discussion and recommendations, except where noted.

Part B—Acquisition of Research and Development

CONTENTS

CHAPTER 1

Introduction and Summary of Recommendations

Research and development (R&D) is an innovative process of scientific and technological preparation for change. Representing about six percent of the Federal budget for fiscal 1972, Government-funded R&D has helped to attain important national goals, particularly in the fields of defense, space exploration, nuclear energy, and health and to provide a broad base of scientific knowledge and trained manpower.

The R&D spectrum is being broadened in new efforts to enhance the quality of life, to support economic growth, and to improve the U.S. position in foreign trade. These new vistas challenge the R&D procurement process. There is still much room for improvement in defining the role and nature of R&D and in the understanding of R&D procurement within the Federal Government and other public sectors. In the procurement of R&D, the Government has the dual objective of (1) supporting the Nation's technological base and (2) acquiring the capability for producing new products and rendering new services. Major problems in the R&D procurement process often have resulted from losing sight of this dual objective.

There is also a continuing need to maximize the effectiveness and efficiency of all Federal R&D activity. A step in this direction would be the clear definition of specific roles and missions for the three major performers of R&D: universities, in-house laboratories, and private industry.

Objectives and Organization

We conclude that the increasing complexity and cost of R&D has made it difficult for some newer agencies to find the resources needed to fulfill their R&D objectives. Such problems can sometimes be solved by seeking help from the older agencies which often possess resources that can be used to fulfill an R&D need of the new agency. It is important that this type of interagency cooperation be encouraged, especially in solving important national problems that are not within the purview of a single agency.

In order for one Federal agency to evaluate the R&D potential of another agency's in-house laboratory, specific information is needed as to the laboratory's capability. We therefore recommend that Federal in-house laboratory directors be given some discretionary funds for demonstrating the laboratory's capability for contributing to the solution of problems outside the mission of its parent agency.

The increase in the scope and magnitude of Federal R&D over the past 25 years has been accompanied by a similar increase in basic research programs. Unfortunately, such programs have been concentrated in a few agencies, principally those with large R&D programs in areas of high technology. We conclude that a basic research program conducted side-by-side with an ongoing R&D program will invariably benefit one another if there is an effective exchange of information between the programs. We recommend that every Federal agency that has an R&D program in direct support of its missions should support an associated program in long-range basic research.

Performers

As a result of our study of R&D roles and missions, we have concluded that the universi-

ties should continue to be the primary performers of basic research and that industry should be the primary source of applied research and product development. In-house laboratories must maintain strong technical competence in order to properly sponsor and manage R&D programs and perform required tests and evaluations.

As a result of our study of Federally funded research and development centers (FFRDCs), including Federal contract research centers (FCRCs) as they are called in the Department of Defense, we conclude that such centers have provided unique technical and management assistance to the Government. We recommend that the option to use such resources should be continued and offer specific guidelines for their initiation and termination.

To achieve progress in certain areas, particularly in the social sector, it has been necessary to develop R&D programs and projects that transcend traditional disciplinary or departmental boundaries. Most recently, there has arisen a compelling need to improve interaction between institutions and organizations in order to accomplish special goals and the primary response has been to form consortia of interacting institutions. We believe increased multi-institutional effort is necessary to improve industrial technology and generally to provide special resources for use by the entire national R&D community. New multi-institutional organizations might be formed from a mix of several types of performers (for example, academic, industrial, and nonprofit), depending on the requirements of the activity to be supported. Multi-institutional organizations might, however, introduce new problems, such as how to deal with questions of restraint of trade and protection of proprietary rights if industrial organizations are involved and how best to administer the programs so as to stimulate R&D. The existing National Science Foundation/National Bureau of Standards experimental incentives programs with consortia of organizations should be closely followed, and the positive results of the programs should be promptly applied.

Procurement Policy

We conclude that Government-wide and uniform regulations for R&D procurement are needed and that competitive negotiation should be an acceptable alternative to formal advertising and the requirement for Secretarial level determination and findings for R&D should be eliminated. These subjects, with specific recommendations, are also discussed in Part A, Chapters 3 and 4.

In other policy considerations, we conclude that unsolicited proposals are a primary method of obtaining creative ideas from the private sector. Some agencies make very effective use of unsolicited proposals in their R&D procurement, but many other agencies do not avail themselves of this very useful technique. Our studies found a trend toward reduced use of this valuable technique, primarily because of recent administrative and legislative actions. This trend should be reversed and restraints that discourage the use of unsolicited proposals should be eliminated.

From our study of cost sharing policy, we conclude that cost sharing in R&D procurement normally serves no useful purpose and it creates unnecessary administrative requirements and costs for both the Government and the performers. We recommend the elimination of cost sharing on R&D projects unless the performer would clearly benefit through commercial sales.

In our study of cost recovery policy, we found two kinds of situations wherein the Government seeks to recover part of its costs for R&D from the performer who directly benefits from the Government-sponsored work. The first involves cost recovery from commercial sales of new products and the second involves cost recovery from foreign military sales. Our studies have led us to the conclusion that it would be in the national interest to remove cost recovery requirements because they interfere with the early application of R&D results. We believe that a more realistic approach would be to establish a cooperative Government-industry effort to maximize the competitive position of U.S. suppliers, and we therefore recommend the elimination of recovery of R&D costs from Government contractors and grantees except under circumstances approved by the agency head.

Our major policy recommendation concerns independent research and development (IR&D). In a price-competitive, firm-fixed-

price procurement the type and amount of costs included in the quoted price are not usually questioned since the competitive situation supplies an automatic control on the amount of reimbursement for direct and indirect costs. However, there are many Government procurement situations where commercial, price-competitive, firm-fixed-price procurements are not suitable, and the matter of cost reimbursement then becomes a problem. The necessity of cost constraints in such situations has led to the development of "substitute" controls to replace those inherent in the price-competitive environment. The application of one of these "substitute" controls—cost principles to govern reimbursement of direct and indirect costs in the cost-type environment—is the key factor involved in the recovery of independent research and development (IR&D) and bid and proposal (B&P) costs. We recommend that IR&D and B&P expenditures be recognized as necessary costs of doing business. We also recommend that such costs receive uniform, Government-wide treatment and that all contractor cost centers with 50 percent or more fixed-price Government contracts and commercial sales should have such costs accepted without question and with no relevancy restriction; all other contractors should be subject to the existing Department of Defense procedures. Two dissenting positions to the above are presented in Chapter 4 of this part of the report.

Procurement Procedures

We conclude that improvements in the procurement process could be realized by reducing the excessive number of proposals often received in answer to a solicitation and by recognizing that the type of contract used should be selected primarily on the basis of the level of uncertainty in program specifications. Recommendations addressing these issues are presented in Part A, Chapters 3 and 4, and Part C.

One procedure which we have considered for reducing the time required to initiate R&D work and simultaneously produce substantial cost savings is the negotiation of master agreements with performer organizations. Once a master agreement is negotiated, all agencies would be able to authorize work by simply negotiating a work order containing the new statement of work without the necessity of negotiating other standard terms and conditions.

It is apparent that the agencies could agree on a master agreement only if there were a high degree of uniformity in the R&D procurement regulations; we believe such agreements are one of the benefits which could be gained from uniform R&D procurement regulations. We recommend the use of such agreements, one type for grants and another for contracts, insofar as possible, for all types of performers.

Not infrequently the Government needs contractor expertise in formulating its plans and, in some cases, writing specifications for goods or services to be purchased. Contractors so employed inevitably gain a unique insight into the proposed program and, in the extreme cases, could theoretically write specifications that only they could satisfy. In the bidding for the resulting contracts, these contractors would have an unfair advantage.

The Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) have attempted to correct such situations by excluding contractors who gain privileged information. The difficulty in using the "hardware exclusion" clause lies in determining when it is warranted. The best contractors will not normally waive their rights to sales simply for the privilege of helping the Government. We conclude that the concept is sound; however, overzealous use of the clause unnecessarily denies the Government access to invaluable assistance. We recommend that when a potential organizational conflict of interest exists and use of a hardware exclusion clause is proposed, a senior official of the procurement agency should be required to examine the circumstances for benefits and detriments to both the Government and the potential contractors and reach and justify his decision to contract with no restraint, partial restraint, or strict hardware exclusion provisions.

CHAPTER 2

Federal Objectives and Organizations

Objectives of Federal R&D Procurement

R&D procurement is an investment that the Government makes to meet its constitutional obligations to "provide for the common Defense and general Welfare of the United States." This has required the establishment of close relationships between the Government and the private sector, because the private sector does 86 percent of all R&D performed in the United States and funds approximately 46 percent of the total national R&D effort.[1]

STRATEGIC GOALS

Federal R&D programs serve certain long-range national objectives. Innovations from R&D help to improve the productivity of the Nation (see Appendix C) and provide the basis for improved products and services at lower costs, thus benefiting large portions of the population.

The innovative and beneficial results of Government-procured R&D have a profound impact on the U.S. economic position in the international marketplace (see Appendix D). The total funding of science and technology in the United States far exceeds the levels in other industrial nations of the free world. This dominance is diminished when data on the U.S. ratios for R&D funding as a percentage of the gross national product (GNP), professional R&D manpower per capita, and graduate enrollment in physical sciences and engineering are examined. Federal R&D spending, estimated at $15.2 billion for fiscal 1972, represents only 6.4 percent of total budget outlays and is in the eighth year of decline since the peak of 12.6 percent in 1965.[2] The United States has always faced strong competition from other countries in markets for most labor-intensive consumer goods. The recent U.S. dominance in high technology is now threatened by rapid developments abroad, and a strong R&D posture is needed to maintain and extend the potential for our position in foreign markets.

The Government has supported R&D because of the need to build and maintain a strong scientific and technological base. The use of scientific research in World War II and the needs of certain critical technologies pertinent to the national security effort in the years following World War II have demonstrated the need for this "base." (See Part C for details on the importance of the technological base for major systems development.) Important parts of this base consist of the generation of new scientific and technological knowledge through the support of university research and the training of new scientific manpower to extend knowledge-generating and knowledge-using capabilities. Extending these capabilities from older, established programs to newer R&D programs in the socially-oriented civilian sector is an increasing challenge.

AGENCY AND INTERAGENCY GOALS

A most immediate and apparent purpose of Federal R&D procurement is to help the vari-

[1] National Science Foundation, *National Patterns of R&D Resources, Funds and Manpower in the United States, 1953–1972*, NSF 72-300, p. vi.

[2] *Ibid.*, p. 4.

Percentage calculated by Commission, using the $15.2 billion compared with estimated 1972 total budget outlays from *Special Analyses of the United States Government, Fiscal Year 1973*, p. 18.

National Science Foundation, *Federal Funds For Research, Development and Other Scientific Activities, Fiscal Years 1969, 1970, and 1971*, NSF 70-38, Vol. XIX, Sept. 1970, p. 2.

ous Government agencies attain their specific mission objectives. These missions are best served by continual advances in the state-of-the-art for each agency. Only through these advances can the agencies be assured that they can procure the best goods, services, facilities, and systems for their own use and provide maximal benefit to the Nation by making sure that improved goods and services are available to the public at the lowest possible costs.

Recommendation 1. Conduct R&D procurement primarily to meet agency missions, but whenever possible be responsive to the needs of other Federal agencies and activities.

Recommendation 2. Allocate a limited amount of funds to each Federal laboratory to be used at the discretion of the laboratory director to initiate R&D projects in support of any national objective. Some of these projects might lie outside the normal mission of the laboratory.

The increasing complexity and cost of R&D have caused serious problems for some agencies in trying to find the resources to fulfill their objectives. It is expensive to create new facilities and train new manpower to perform R&D functions. Established programs of older agencies often provide potentially suitable resources to accomplish new functions. For example, the Atomic Energy Commission (AEC) has provided the National Institutes of Health (NIH) with the facilities and talents needed to help develop nuclear-powered cardiac-assist devices. The Department of Housing and Urban Development (HUD) relies on the Department of Commerce's National Bureau of Standards to perform research aimed at developing materials needed in housing technology.

The most striking example of agency impact on and cooperation with other agency R&D programs is NASA's early interaction (as NACA) with DOD in aircraft development. These collaborative efforts still continue in areas of aircraft development and missile R&D. Equally significant are NASA's contributions to the civilian sector, including the weather satellites that were developed with the National Oceanographic and Atmospheric Administration in Commerce and the communications satellites that were developed with the Federal Communications Commission. Also of great importance to other agency R&D programs are such efforts as satellite detection of diseased crops (Agriculture), natural resources (Interior), and pollutants (Environmental Protection Agency (EPA)). NASA also has contributed to important advances in instrumentation for distant monitoring of physiological functions that are applied by the Department of Health, Education, and Welfare (HEW) programs aimed at the treatment of human disease. This interagency cooperation could be further improved if Federal in-house laboratory directors had some discretionary funds that can be used to demonstrate the laboratories' capability to contribute to mission objectives outside those of their parent agencies.

PRIVATE SECTOR CAPABILITY

With rare exceptions, the private sector engages in R&D only if it expects commercial sales, patent royalties, or other benefits from the undertaking. In most defense and space fields, no commercial benefits can be expected since the Government is the only buyer and therefore must support practically all R&D effort.

Government support of R&D may also be required in fields where many uncertainties face the private sector. An example is basic research, which lays the foundation for applied and development efforts toward creation of usable products or services that sometimes require years of effort before the findings and follow-on development can be practically applied. As a result, most basic research efforts are concentrated in the academic community and in in-house Government laboratories. There is a need for special considerations on how best to support these efforts.

Even if there is potential for future commercial application of basic research, private enterprise may not be able or willing to risk the large development investments required, and some Government support may be needed.[3] Stimulation of nuclear power development by the AEC demonstrates how the large investments required and many inherent uncertainties involved can necessitate Government

[3] *Government Executive*, Sept. 1972, pp. 39–45.

support. Increased industrial capability established through years of Government-private sector interaction should eventually permit the private sector to profitably and reasonably take over the major portion of later R&D effort, as demonstrated by the AEC programs for nuclear power development. The Government must find the best means to accomplish these ends and to improve the Nation's creative and productive capability. A Federal income tax credit for R&D might be one such vehicle.

The following suggestions have long-range potential for procurement. Because they fall within the missions of the National Science Foundation (NSF) and the Department of Commerce, these agencies should consider their feasibility and advisability.

- Establish a program of matching-fund contracts or grants to enable individual companies to explore innovative technical directions which the companies believe would lead to the creation of entirely new industries.

- Encourage technological advancement by supporting the development of markets requiring high-technology products, particularly when the Government is the prime customer. Establish Federal/State/local matching-fund programs for those nationally critical, high-technology areas (such as mass transit, health care, housing, technological training) with markets that are too diffuse or underfinanced to provide good market potentials or when the cost of the solution is too high for local or State governments to assume.

- Stimulate technological growth by establishing a graduate-level, training and retraining program to develop specialized, high-technology skills currently in short supply or anticipated to be in demand in the near future.

- Procure R&D directed toward product development in any field relevant to the national well-being that is not adequately supported by the private sector. Such R&D should be conducted in a manner that:

  Produces a competitive, private-sector capability to pursue the product development.

  Encourages the private sector to take over the ongoing financial support of the new field, including further R&D, after the activity has become viable.

BASIC RESEARCH AND ADVANCED STUDIES

The largest fraction of all basic research support is located in a few Government agencies. It is contended that this concentration has biased the development of basic research fields toward the specific missions of such agencies as DOD, AEC, NASA, and NIH. The application of science and technology to broader national problems will require significant input from the social sciences and from the sense of mission embodied in many other Government agencies.

Recommendation 3. Encourage, through the Office of Science and Technology, every Federal agency that has an R&D program in direct support of its missions and objectives to generate an associated program in long-range basic research and advanced studies and to support it at a level appropriate to the agency's needs.

The terms basic research and R&D are closely identified with the physical and biological sciences and their associated engineering technologies. Analogous activities in the social, economic, and political sciences frequently are included in the same terminology, but this is often inappropriate and misleading. A simple, comprehensive term that covers basic activities in all of these fields is basic research and advanced studies.

The major basic research and advanced studies programs have been concentrated in agencies that have large R&D programs in high-technology areas. There are convincing reasons to support basic research and advanced studies programs in every Federal agency that has an R&D program, especially in newly developing fields that require social and technological input. Basic research and advanced studies programs contribute to:

- Development and organization of the knowledge base that will support applied research and development programs of the future

- Development of an informed manpower base needed for all future applied and operational programs
- Maintenance of an innovative climate and a healthy, challenging skepticism in the entire R&D community
- Development of important mechanisms for linking the applied R&D programs of the agency to the entire research and advanced studies community
- General understanding that it is vitally important that the Nation be committed to the long-range study of all of the complex issues that arise in a rapidly changing, technological society.

A basic research and advanced studies program developed in parallel with an ongoing R&D program will invariably profit from that association if there is an effective exchange of information between the programs. This arrangement is valuable in newly emerging programs and also in established disciplines.

A more general concern over the rational development and coordination of all Federal R&D activities is well documented in the legislative history of the National Science Foundation (NSF)[4] and of the Office of Science and Technology (OST).[5] In basic research, the NSF has helped to lend breadth and stability to a wide range of national programs, but no effective mechanisms have been developed for continuously coupling these programs to the needs of agencies other than NSF. This classic dilemma is clearly illustrated in the recent establishment, within NSF, of a large program in Research Applied to National Needs (RANN).[6] The RANN program uses the strengths of NSF to help provide some measure of the basic and applied research needed by many of the new agencies. In conjunction with related expansions in the total NSF budget, it shifts the distribution of priorities for basic research and advanced studies away from the agencies that have dominated it. The program also tries to communicate the urgent need for immediate and short-term relevance to the community that performs basic research and advanced studies.

Among mission-oriented Government agencies, the distribution of priorities for the support of basic research and advanced studies has become closely identified with the concept of short-term relevance.[7] This was highlighted in Public Law 91–121 which authorized DOD appropriations for fiscal 1970. Section 203 of the law provided that: "None of the funds authorized to be appropriated by this Act may be used to carry out any research project or study unless such a project or study has a direct or apparent relationship to a specific military function or operation." In authorizing funds for fiscal 1971, Public Law 91–441 did not contain this specific constraint. Instead, section 204 reads: "None of the funds authorized to be appropriated to the Department of Defense by this or any other Act may be used to finance any research project or study unless such project or study has, in the opinion of the Secretary of Defense, a potential relationship to a military function or operation."

The wording of the latter statement is entirely consistent with the principle of providing support for long-range basic research and advanced studies in mission-oriented agencies. It simply demands an appraisal of the "reasonable expectation" of its ultimate value to the agency. Nevertheless, the combined force of the two statements has been interpreted by many observers as a demand for more short-term relevance in basic research.

There is a long history of support for the

[4] U.S. Congress, House, Committee on Science and Astronautics, *The National Science Foundation—A General Review of Its First 15 Years*, H. Rept. 1219, 89th Cong., 2d sess., 1966.

U.S. Congress, House, Committee on Science and Astronautics, *The National Science Foundation—Its Present and Future*, H. Rept. 1236, 89th Cong., 2d sess., 1966.

[5] U.S. Congress, House, Committee on Government Operations, *The Office of Science and Technology*, report of the Science Policy Research Division of the Legislative Reference Service, Library of Congress, for the Military Operations Subcommittee, Mar. 1967.

U.S. Congress, House, Committee on Science and Astronautics, *Creation of the Office of Science and Technology*, study by the staff of the Committee, 87th Cong., 2d sess., 1962.

[6] McElroy, "New Directions in the Nation's Science Policies," *Congressional Record*, May 6, 1971, p. S6349.

National Science Foundation, *Research Applied to National Needs*, NSF 71–21, Sept. 1971.

U.S. Congress, House, Committee on Science and Astronautics, *Interdisciplinary Research Relevant to Problems of Our Society*, Hearings before the Subcommittee on Science Research and Development on the 1970 National Science Foundation Authorization, vol. II, Mar.-Apr. 1969.

[7] Nichols, "Mission-Oriented R&D," *Science*, Apr. 2, 1971.

U.S. Congress, House, Committee on Science and Astronautics, *Mission Agency Support of Basic Research*, report of the Subcommittee on Science, Research, and Development, 91st Cong., 2d sess., Feb. 25, 1970, p. 3.

broad distribution of basic research.[8] Multi-agency support long has been recognized as an important element in the successful development of national capabilities in the physical, biological, and engineering sciences. If every Federal agency engaged in R&D developed an associated basic research and advanced studies program, it would guarantee that a pluralistic support base in newly emerging fields would be developed.

If this conclusion is accepted, the simplest policy guidelines for coupling basic research and advanced studies to the long-term needs of Federal programs is to support it at a reasonable fraction of the total R&D budget in each agency. Congress and the executive branch continuously analyze priorities for the overall programs of Federal agencies, and the annual budgets reflect these deliberations. Moreover, within these budgets are detailed accountings of the total R&D efforts for each agency. This is the most accurate reflection of current national priorities that can be developed.

The Office of Science and Technology has recently devoted increased attention to coordinating the activities of the agencies engaged in basic research and advanced study.[9] Significant examples of this are the OST Interagency Advisory Committee for NSF's RANN program and the current joint efforts of OST and NSF to gather information from all agencies that support research in the field of chemistry.

Because basic research and advanced studies projects are frequently a part of ongoing demonstration or applied R&D programs in many agencies, it is difficult to coordinate the projects. If an agency is to participate effectively in any interagency system for the coordination of basic research and advanced studies, there must be a central focus for the studies within the agency.

All sponsoring agencies and all types of performers favor a multi-agency support system close to the one now in existence rather than a new system based on a single super-procurement agency. NSF is being delegated the responsibility for administering a growing share of Federal support for basic research and advanced study. This is a healthy, important trend, but mission-oriented agencies should continue to support programs of appropriate size.

Although it has major strengths, the present multi-agency system for the procurement of basic research and advanced studies needs significant improvement. The individual procurement system is good in agencies that have depended strongly on basic research during the last two decades, notably HEW, AEC, NASA, DOD, and NSF. However, the diversity of procedures used by these agencies often causes performers extra cost and difficulties. In the other agencies, including most of the ones that have rapidly growing R&D needs, the procurement systems are mediocre to poor. Many of the agencies with newly emerging R&D programs have not yet developed a central focus for their long-term needs and have not developed an effective procurement system for basic research and advanced studies. Thus it is not surprising that many deficiencies in the procurement systems derive from not giving adequate attention to the differences between procurement for development and that for basic research and advanced studies.

Government Organization for R&D Procurement

Federal procurement of R&D is examined by several levels of the legislative and executive branches. In both the Senate and House, various legislative and appropriation committees review and assess the R&D programs of the agencies within their purview. Special committees and subcommittees were established in the post-World War II years and especially during the late 1950's to devote special attention to R&D problems, particularly in the field of space. The most representative of the continuing congressional interests in this direction are the Senate Committee on Aeronautical and Space Sciences, the House Committee on Science and Astronautics, the Armed Services Committees of both houses, and the Joint Committee on Atomic Energy. Collaborating closely with these committees

[8] Donnelly, *Highlights of Congressional Action on Limiting Defense Funded Research to That Which Has a Direct or Apparent Relationship to a Specific Military Function or Operation*, Legislative Reference Service, Mar. 25, 1970.
Congressional Record, Nov. 25, 1969, p. S14969.
Congressional Record, Mar. 20, 1970, p. S4080.

[9] Note 5, *supra*.

and other members of Congress is the staff of the Science Policy Research Division of the Legislative Reference Service of the Library of Congress. A recent statute [10] establishing a Congressional Office of Technology Assessment is a step toward strengthening these review capabilities in the legislative branch.

The highest levels of executive branch overview of Federal R&D start in the Executive Office of the President, where science and technology programs receive the attention of the Science Advisor to the President, the Office of Science and Technology, the President's Science Advisory Committee, and the Federal Council for Science and Technology. Specific areas of science and technology are under the purview of the National Aeronautics and Space Council, the National Council on Marine Resources and Engineering Development, and the Council on Environmental Quality. Further broad reviews are provided by the Office of Management and Budget.

Six executive departments and the three armed services have offices of an Assistant Secretary or Deputy Under Secretary for Research, Science, Technology, or similar designation; three other departments, including DOD, assign other equivalent titles. Two departments have no such office. Eight independent agencies also have high administrative officials responsible for the R&D function (see table 1).

[10] Public Law 92-484, Technology Assessment.

TABLE 1. U.S. GOVERNMENT OFFICIALS WITH DEPARTMENT AND AGENCY R&D PROGRAM RESPONSIBILITIES

Department	*Assistant Secretary*	*Other Designation*
Agriculture		Science and Education, Director
Commerce	Science and Technology	
Defense		Director, Defense Research and Engineering
Army	Research and Development	
Navy	Research and Development	
Air Force	Research and Development	
HEW	Health and Scientific Affairs	
HUD	Research and Technology	
Interior	Science and Engineering (Dep. Under Secy.)	
Justice	----------	----------
Labor	Policy, Evaluation, and Research	
State		Director, Bureau of International Scientific and Technological Affairs
Transportation	Systems Development and Technology	
Treasury	----------	----------
Agency		
Atomic Energy Commission		Assistant General Manager, Research and Development
Environmental Protection Agency		Assistant Administrator, Research and Monitoring
National Aeronautics and Space Administration		Associate Administrator(s), (a) Space Science; and (b) Aeronautics and Space Technology
National Science Foundation		Deputy Assistant Director, Research
Smithsonian Institution		Assistant Secretary, Science
Postal Service		Assistant Postmaster Gen., Research
Veterans Administration		Assist. Chief Medical Dir., Research and Education in Medicine
Office of Economic Opportunity		Assistant Director, Planning, Research, and Evaluation

Source: Commission Studies Program.

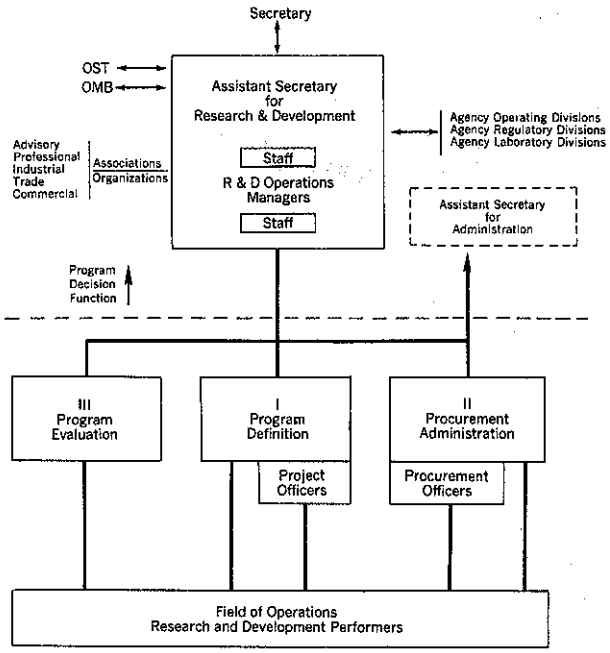
While all these officials deal primarily with R&D program content and direction, R&D procurement functions are generally the responsibility of an Assistant Secretary for Administration or a similar official. Efficient and effective R&D procurement requires close collaboration between officials and the staffs responsible for both these functions. In figure 1, R&D program management is shown in blocks I and III and R&D procurement responsibilities in block II. Typical interactions are indicated, for example, with other executive offices, other agency divisions, and organizations and individuals outside Government.

Federal R&D Funding

Prior to World War II, Federal funding of R&D represented less than one percent of the Federal budget.[11] Stimulated by wartime necessities the national R&D expenditures climbed to $198 million in fiscal 1941 and reached about $1.6 billion in fiscal 1945. During the early 1950's, growth in total Federal R&D was

[11] National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1969, 1970, and 1971*, NSF 70-38, Sept. 1970, p. 2.

GOVERNMENT AGENCY OPERATION FOR R & D PROCUREMENT AND ADMINISTRATION



Source: Commission Studies Program.

Figure 1

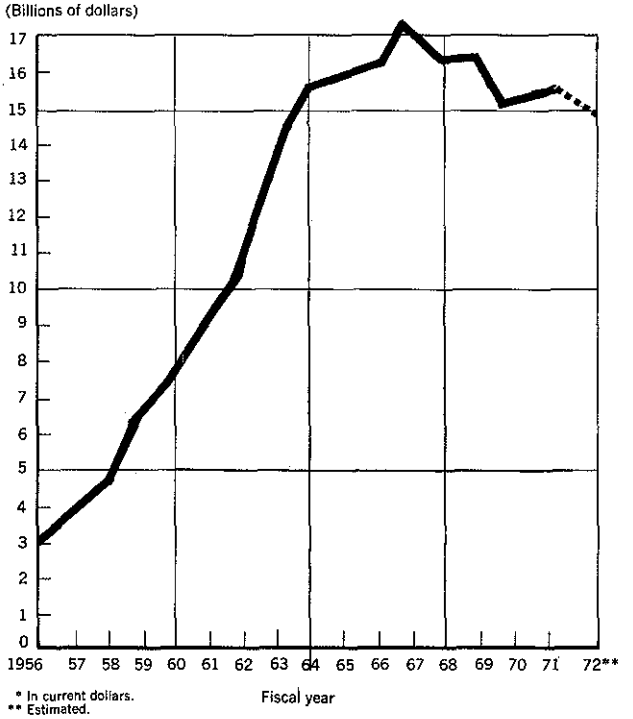
TABLE 2. FISCAL 1971 OBLIGATIONS*
(Millions of dollars)

Agency	*Basic research*	*Applied research*	*Development*	*Total*
DOD	261.5	1,351.4	5,896.1	7,509.0
NASA	680.3	816.7	1,761.0	3,258.0
AEC	277.0	152.1	873.9	1,303.0
HEW	397.3	905.0	173.7	1,476.0
NSF	272.6	45.7	18.6	336.9
Agriculture	118.4	173.7	12.7	304.8
Commerce	41.8	71.9	30.0	143.7
HUD	0.0	10.5	37.2	47.7
Interior	52.7	86.4	54.7	193.8
Justice	0.0	6.5	3.8	10.3
Labor	2.5	11.1	9.2	22.8
Postal Service	0.0	1.0	38.7	39.7
State	0.0	29.0	1.1	30.1
DOT	0.3	172.8	309.3	482.4
Treasury	0.0	0.4	0.4	0.8
EPA	6.1	47.7	82.9	136.7
OEO	3.2	59.9	90.0	153.1
Smithsonian	15.1	0.0	0.0	15.1
VA	3.1	59.0	0.8	62.9
Other	0.4	17.1	5.2	22.7
Total	2,132.3	4,017.9	9,399.3	15,549.5

*Data rounded by the Commission.

Source: National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities*, vol. XXI, tables C-29, C-48, and C-67.

TRENDS IN FEDERAL R&D OBLIGATIONS*



* In current dollars.
** Estimated.

Sources: National Science Foundation. Report 70–38. *Federal Funds for Research, Development, and Other Scientific Activities. Fiscal Years 1969–1971*, vol. XIX, Sept. 1970, p. 2. (1956–1969)

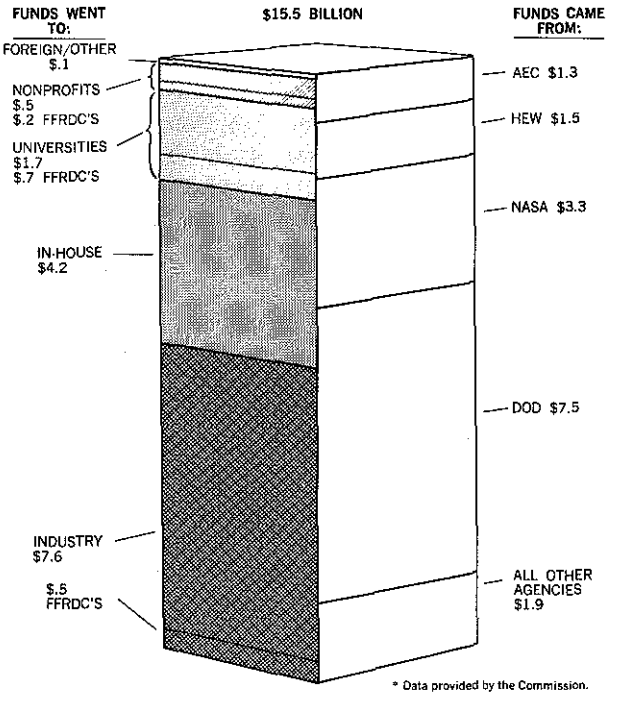
National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1970, 1971, 1972*, vol. XX, pp. 92–93. (1970)

National Science Foundation, *Federal Funds for Research, Development, and other Scientific Activities*, vol. XXI, Table C–7. (1971)

National Science Foundation, Report NSF 72–300, *National Patterns of R&D Resources, Funds and Manpower in the United States, 1953–1972*, p. 4. (1972)

Figure 2

FEDERAL R&D FUNDING—FISCAL 1971*



Source: National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities*, vol. XXI, table C–7.

Figure 3

slow but steady. By 1957 the growth rate accelerated, reaching a peak of over 12 percent of Federal budget outlays in 1964–1965, and an expenditure peak of $17.0 billion in fiscal 1968 (see fig. 2).[12] The total R&D obligations declined after 1967 to $15.5 billion in fiscal 1971. This represents about seven percent of the Federal budget.[13] R&D obligations are expected to total $15.2 billion in fiscal 1972 [14] and $17.8 billion in fiscal 1973.[15]

Complete data for fiscal 1971 are summarized in table 2 and figure 3. Nearly half of the total R&D was funded by DOD, 24 percent by NASA, 9 percent by AEC, and 8 percent by HEW. Smaller expenditures were made by the National Science Foundation and the departments of Transportation, Agriculture, and Interior, and other departments and agencies. These data include funds for some major system developments that are beyond the scope of this part of the report. A detailed treatment of R&D funding by DOD relating to major systems may be found in Part C, Chapter 4.

[12] *Ibid.*

[13] Calculated by the Commission from data in *Special Analyses of the United States Government, Fiscal Year 1973*, p. 18, compared with the $15.5 billion.

[14] Note 2, *supra*, p. 4.

[15] *Special Analyses of the United States Government, Fiscal Year 1973*, p. 281.

CHAPTER 3

Performers of Research and Development

The Government relies to varying degrees on different types of performer institutions and organizations to fulfill the wide scope of its R&D needs. The distribution of performer funding within the total R&D budget of $15.5 billion for fiscal 1971 is presented in table 1.

TABLE 1. DISTRIBUTION OF FEDERAL R&D BY PERFORMER CLASS, FISCAL 1971* (Millions of dollars)

Performer class	*Total*
In-house laboratories	4,166
FFRDCs	1,419
Universities	1,644
Nonprofit research institutions	486
Industry	7,630
Other	204
Total	15,549

*Data rounded by the Commission.

Source: National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities*, vol. XXI, table C–7.

Certain patterns characterize the distribution of funds by different agencies to different R&D performers. For example, in-house laboratories and industry receive the major share of DOD, NASA, DOT, and EPA funding. All of these agencies are involved considerably with development of hardware or processes that are important in the industrial sector. AEC relies heavily on its Government-owned, contractor-operated (GOCO) laboratories, and HEW and NSF use academic performers predominantly. Nonprofit institutions are prominent in Office of Economic Opportunity (OEO) programs, while in-house laboratories dominate the R&D efforts of such old-line agencies as Agriculture, Commerce, and Interior.

Some aspects of civilian agency R&D growth, arising from new priorities and requirements in agencies previously performing or procuring little R&D, are a principal source of the needs and opportunities for improvement in Federal R&D procurement policies and procedures. R&D is decreasing in the hardware-oriented agencies, whose missions mostly serve the Government as a consumer, but it is increasing in civilian-service agencies whose R&D goals ultimately develop community services and economic resources used by the public. The need for these agencies to improve their R&D procurement techniques highlights the need for Government-wide improvements in policies and procedures for R&D procurement.

Federal Research and Development Laboratories

Federal in-house R&D has increased steadily year after year; between 1960 and 1968 the dollar obligations doubled. Between 1969 and 1972 obligations are expected to rise by about 18 percent. In fiscal years 1970–1972, Federal in-house work represented about 25 percent of all Federal R&D, a higher level than prevailed during the 1960's.[1] Table 2 shows the total R&D obligations for each agency for fiscal 1970 and the amount and percentage allocated to in-house laboratories. As noted in table 2, DOD obligates nearly 50 percent of the total Federal R&D funds and expends 27 percent of its obligation on in-house activity. Most of DOD's R&D funds are spent on R&D related

[1] National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1970–1972*, NSF 71–35, vol. XX, p. 24.

TABLE 2. FEDERAL AGENCY R&D AND IN-HOUSE FUNDING, FISCAL 1970*
(Millions of dollars)

Agency	*Total*	*In-House*	
Agriculture	281	208	(74%)
Commerce	122	88	(72%)
Defense	7,360	1,996	(27%)
HEW	1,221	247	(20%)
HUD	30	4	(13%)
Interior	158	100	(63%)
Justice	9	1	(11%)
Labor	21	10	(48%)
Postal	39	8	(21%)
State	28	6	(21%)
Transportation	317	64	(20%)
AEC	1,346	17	(1%)
EPA	89	26	(29%)
NASA	3,800	988	(26%)
NSF	289	14	(5%)
OEO	123	7	(6%)
Smithsonian	18	17	(94%)
VA	59	57	(97%)
Others	20	18	(90%)
Total	15,330	3,876	(25.3%)

*Data rounded and percentages calculated by the Commission.

Source: National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1970, 1971, and 1972*, NSF 71-35, vol. XX.

to major weapon systems as discussed in detail in Part C, Chapter 4.

In relation to the total work of all performers in each R&D category, the Federal in-house laboratories perform a larger percentage of basic and applied research than development work. The latter is performed largely by industry. However, in actual dollars the laboratories' major effort is development. Table 3 shows the in-house R&D effort by category for fiscal 1970.

Recommendation 4. Strengthen in-house capabilities to support technology advancement in the private sector, and specifically the procurement-related technical and management capabilities in laboratories by:

(a) Clarifying the assigned roles of the laboratories;

(b) Providing training and temporary assignment of technical manpower to intra-agency and interagency program management offices and regulatory bodies;

(c) Undertaking test and evaluation (T&E) of conceptual design, hardware, and systems that are proposed, designed, and built by private sources; and

(d) Maintaining technical competence by continuing to conduct basic and applied research and development projects.

In addition to the above recommended in-house roles, we believe that Government laboratories should specifically conduct R&D related to instrumentation standards; large, unique Government facilities; and appropriate systems analyses. It is often difficult to draw a clear line between the type of R&D performed by in-house laboratories and the type performed by other organizational resources. Similar projects might be conducted by an in-house laboratory, an FFRDC, a university, a nonprofit research institute, and a commercial firm.

There is some evidence that past practice and tradition have been factors in Government agency choices between available resources. The older agencies (such as Agriculture, Interior, and Commerce) perform more than 50 percent of their R&D and an even higher percentage of their basic and applied research in-house. Newer agencies (such as AEC, NASA, and HEW) have relied more extensively on the private sector, possibly because they do not have adequate in-house laboratory facilities. DOD originally performed a substantial amount of R&D in its own laboratories, but as requirements have increased (both in volume and complexity), support from outside resources was needed.

The efficiency and effectiveness of the Federal laboratories are very difficult to measure. The Harry Diamond Laboratory has done outstanding work in special research areas; the

TABLE 3. R&D FUNDING BY CATEGORY—FISCAL 1970*
(Millions of dollars)

Category	*In-house*		*Total*
Basic research	658	(31.9%)	2,062
Applied research	1,375	(38.8%)	3,540
Development	1,843	(18.9%)	9,728
Total	3,876	(25.3%)	15,330

*Data rounded and percentages calculated by Commission.

Source: National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities*, NSF 71-35, vol. XX, pp. 9, 16, and 21.

Naval Weapons Center at China Lake was the primary developer of the Sidewinder Missile; the NIH and NASA laboratories have a worldwide reputation for excellence in basic and applied research.

Countering these examples is a body of opinion in the technical community, in and out of Government,[2] that contends that, notwithstanding the few excellent installations, the overall record of Federal laboratories is poor. The Government, particularly DOD, has consistently turned to industry and the research institutes for the critical concept formulation leading to the in-house decision on concept selection and for systems engineering, design, and development (see Part C). When in-house capability has been used for these critical functions, the results have not been particularly effective.

The role of the Federal laboratories has been the subject of considerable study and controversy during the past two decades.[3] These analyses concluded that: Federal laboratories have contributed significantly in basic and early applied research in the fields of health, medicine, munitions, and aerodynamics, and have not contributed significantly in other fields. The contribution of the Federal laboratories to systems engineering and technical management/direction has been spotty. Technical support to the systems project offices has been minimal although recently the Army has tried to improve the laboratory contribution by establishing a liaison position in each system project office. Contract administration and technical management at the subsystem, weapon, component, and applied research levels appear to be the chief function of most Federal laboratories, particularly DOD laboratories (see Part C).

The most comprehensive study of Federal laboratories resulted in the Bell Report to the President on April 30, 1962.[4] The report was authored by the heads of DOD, AEC, NASA, NSF, and the Civil Service Commission; the Special Assistant to the President for Science and Technology; and David E. Bell, the Director of the Bureau of the Budget. The most significant conclusions from this report were that:

- The Government should continue to rely heavily on contracts with the private sector for scientific and technical work, but the management and control of these programs must be the responsibility of Government officials.
- Choices between available resources for R&D work should be based on efficiency and effectiveness, with due regard for maintenance of public and private scientific resources.
- The contracting system should be improved, and the working environment in Government R&D establishments should be improved to attract and hold first-class personnel.

The report stressed that:

> We consider that in recent years there has been a serious trend toward eroding the competence of the Government's research and development establishments—in part owing to the keen competition for scarce talent which has come from Government contractors. We believe it to be highly important to improve this situation—not by setting artificial or arbitrary limits on Government contractors but by sharply improving the working environment within the Government, in order to attract and hold first-class scientists and technicians. In our

[2] Brooks, "Needed: More Freedom for Our National Labs," *Scientific Research*, Feb. 1967, pp. 52–53.

Glass, *DOD Laboratories in the Future*, MAM 67–3, U.S. Department of Defense, Office of the Director of Defense Research and Engineering, Oct. 1967, p. 9.

Hornig, "Federal Research Laboratories," *Science*, vol. 160, May 10, 1968, pp. 627–628.

Spinrad, "Converting AEC to a TEC: Technological Excellence Commission," *Nucleonics*, June 1967, pp. 52–53.

Spivak, "Survival Problem for the Federal Labs," *Wall Street Journal*, Dec. 21, 1967, p. 120.

Weinberg, "The Federal Laboratories and Science Education," *Science*, vol. 36, Apr. 6, 1962, pp. 27–30.

[3] U.S. Department of Defense, *Report of the Task Group on Defense In-House Laboratories*, July 1, 1971, p. 98.

U.S. Department of Defense, Office of the Director of Defense Research and Engineering, *Methods of Evaluation, R&D Organizations*, Management Analyses Memorandum 70–1, by E. M. Glass, June 15, 1970, p. 22.

Carey, *The Federal Research Laboratories*, remarks at the National Conference on the Administration of Research, Wilmington, N.C., Sept. 30, 1971, p. 8.

U.S. Congress, House, Committee on Science and Astronautics, *Utilization of Federal Laboratories*, Hearings before the Subcommittee on Science, Research, and Development, 90th Cong., 2d sess., Mar. 26–28, Apr. 2–4, 1968, p. 457.

[4] U.S. Bureau of the Budget, *Government Contracting for Research and Development; Report to the President*, commonly called the "Bell Report." Submitted by the President of the United States to the U.S. Senate and reproduced as Senate Document No. 94, 87th Cong., 2d sess., 1962.

judgment, the most important improvements that are needed within Government are: to ensure that governmental research and development establishments are assigned significant and challenging work . . .

There must be sufficient technical competence within the Government so that outside technical advice does not become de facto technical decision-making.

The Bell Report obviously was well received by the President and Congress, and many of its recommendations have been implemented. Civil Service salaries have been made much more competitive with universities, industry, and other institutions, and more supergrade positions have been provided for the various Government laboratories.

Federally Funded Research and Development Centers

The Federally funded research and development centers (FFRDC), including the Federal contract research centers (FCRC) as they are designated in DOD, operate under long-term commitments to Federal agencies to perform or administer R&D, systems management, or study and analysis. The sponsoring agency has the responsibility for continuity of the center through funding its efforts and provides some degree of supervision of its activities. Organizations currently classed as FFRDCs are operated by nonprofit organizations such as universities and independent research institutes or by nonprofit corporations formed solely to operate specific centers. Exceptions to this generality are the GOCO facilities of the Atomic Energy Commission that perform R&D and can be classified as FFRDCs. Some GOCO facilities are operated by industrial firms. (See Part A, Chapter 6).

Recommendation 5. Continue the option to organize and use FFRDCs to satisfy needs that cannot be satisfied effectively by other organizational resources. Any proposal for a new FFRDC should be reviewed and approved by the agency head and special attention should be given to the method of termination, including ownership of assets, when the need for the FFRDC no longer exists. Existing FFRDCs should be evaluated by the agency head periodically (perhaps every three years) for continued need.

In 1967, the Federal Council for Science and Technology prescribed criteria for identifying an FFRDC and now maintains a master list of the activities officially included in this category. In an October 1971 publication,[5] NSF listed 70 FFRDCs; 15 FFRDCs sponsored by DOD, 27 educational laboratories funded by the Office of Education (HEW), 21 of the AEC GOCO research facilities, and 7 others.

The FCRCs of DOD have received most of

[5] Note 1, *supra*, pp. 75–76.

TABLE 4. FCRCs OF THE DEPARTMENT OF DEFENSE

FCRC	*Total personnel*	*Fiscal 1969 program ($000)**
Aerospace Corp. (USAF)	3,346	74,272
Analytic Services Inc. (USAF)	93	1,572
Applied Physics Laboratory, Johns Hopkins Univ. (USN)	2,388	46,277
Applied Physics Laboratory, Univ. of Wash. (USN)	123	2,171
Center for Naval Analyses (USN)	452	9,200
Human Resources Research Organization (HumRRO) (USA)	233	4,200
Inst. for Def. Analyses (OSD)	624	11,780
Lincoln Lab (USAF)	1,753	67,573
Mitre Corp. (USAF)	2,176	34,131
Ordnance Research Laboratory, Penn State (USN)	448	8,558
Rand Corp. (USAF)	1,213	21,171
Research Analysis Corp. (USA)	561	8,350
Total	13,410	289,255

*Rounded by the Commission.

Source: National Science Foundation, *Directory of Federal R&D Installations for the Year Ending June 30, 1969*, NSF 70–23, 1970, pp. 203, 209, 219, 243, 249, 253, 321, 357, 389, 391, 401, and 437.

the recent attention and criticism directed at FFRDCs. These organizations are listed in table 4, which also provides data on employment and program volume for 1969.

The first of the current FCRCs was the Applied Physics Laboratory at Johns Hopkins University, which was organized in 1942 at the request of the wartime Office of Scientific Research and Development (OSRD). It gave central direction and technological support to an association of universities and industrial contractors being organized by OSRD to develop new concepts for weapon systems.

In the post-World War II years, comparatively low Government pay scales for professional personnel, a lack of desire by the defense agencies to develop a permanent staff for highly specialized analytical work (it was believed that the need would be sporadic), the increasing sophistication and complexity of weapon systems, and the high degree of special competence and skills required led Government agencies to seek temporary assistance from outside groups of recognized experts for long-range strategic analysis, systems analysis, system engineering, and research in specific disciplines.[6]

This led to the establishment of additional FCRCs in three general areas: (1) strategic analysis and systems analysis offered by FCRCs such as Rand, Center for Naval Analyses, and the Institute for Defense Analyses; (2) systems engineering by such FCRCs as Aerospace and Mitre; and (3) research in specific areas offered by such FCRCs as the Ordnance Research Laboratory at Penn State.

Although it was originally anticipated that the need for these institutions would be temporary, a continuing flow of new and extended requirements for their special services kept them in business and caused their numbers to increase. They depend almost entirely on Federal contracts for their business, but otherwise operate as independent enterprises.

These private institutions continue to be in a position to provide unique and valuable services to their sponsoring agencies. Because they have been successful in attracting many talented professionals possessing special skills and expertise in a diversity of fields, they can offer the services of multidisciplinary analytical teams. Although largely dependent on the Government agencies for their existence, they operate outside of the Government structure and have an independent perspective on their analytical work. In principle, they are not tied to the particular sets of objectives and commitments that characterize the agencies, and their objectivity is not constrained by any profit or product bias that might arise in the profit-motivated sector. The independence and flexibility they enjoy give them the freedom to explore many issues of potential importance to national defense or other public interests before these issues demand immediate action. Over the past two decades, the FCRCs have become an intrinsic part of the analytical research and development activities of the Federal Government.

Initially, the activities of the Federal Contract Research Centers were specifically directed to tasks for the defense agencies. Their capabilities were tailored to meet these agencies' immediate needs. The increasing demands on these research groups have resulted in their becoming sizeable private organizations over the years. Their growth has been accompanied by an expansion and diversification of their capabilities, and as a result they have attracted other clients. Some of these groups are now able to serve in additional capacities. Federal civilian agencies, and other organizations within and outside of the Government, now employ the services of FCRCs and other FFRDCs.

A growing public awareness of the operation of these research organizations has accompanied the recent expansion of their interests and capabilities. The increasing importance these organizations have in the Federal research network has begun to create some public concern.[7] This concern is an indication that change is imminent in the environment in which these institutions operate.

On November 11, 1971, the House Committee on Appropriations indicated the possibility that the time has come for a substantial change in philosophy regarding Federal use of the private strategic and system analysis institutions. This was expressed by the committee

[6] Trainor, "Government Use of Nonprofit Companies," *Harvard Business Review*, vol. 44, May-June 1966, p. 39.

[7] Coddington and Millikin, "Future of Federal Contract Research Centers," *Harvard Business Review*, Mar.–Apr. 1970, p. 103.

in its report on the DOD Appropriation Bill for fiscal 1972. In essence, the committee directed DOD to reduce its use of the Rand Corporation, Research Analysis Corporation, Center for Naval Analyses, and Institute for Defense Analyses. The committee recommended a cutback of approximately 25 percent in the budget requests for each of the four research operations for fiscal 1972 and indicated that it expects further cutbacks in future years.[8]

One fundamental reason underlying the recommendation for reduced FCRC funding levels is the committee's expressed desire that DOD's in-house analytical capabilities be developed and used. The committee believes that the development of these internal capabilities is a viable and desirable alternative to the now extensive dependence of DOD on the resources of outside organizations. It anticipates that numerous benefits would result from use of in-house operations. It would allow the military and civilian personnel responsible for the efforts of the U.S. armed forces to more directly participate in the studies and analyses that are fundamental to program planning, and it may result in greater economy, since Government personnel are under regulations concerning salaries and benefits that are not applicable to nongovernment employees.

The committee also believes that the level of proficiency and pay in Government service, combined with the educational and training benefits available to military and civilian personnel, should make possible the establishment of in-house analysis capabilities at this time.

It should be observed that the FCRCs have brought an objectivity to strategic and systems analysis that, if properly used, could minimize the biases inherent in the roles and mission assignments that involve interservice rivalries (see Part C). The FCRCs involved in systems engineering have long filled a need for a technically competent interface between the system project office and industry. Using in-house resources to meet this need is difficult and decreases the Government's reliance on the private sector. However, filling this need via industry creates certain problems of conflict of interest that neither Government nor industry wishes to raise.

The House committee recommendations probably will substantially affect the future development and performance of the FCRCs, particularly those in strategic and systems analysis. If DOD's funding of these groups is further reduced in future years, the capabilities of these research institutions probably will be accelerated toward new interests and new clientele. More of the future work of these organizations probably will be directed toward the solution of widespread domestic problems, and decreasing attention probably will be given to analytical work for DOD.

As a result of our study we have concluded that, wherever practical, FFRDCs should not be completely funded by single agencies of the Federal Government in order to avoid a "captive" relationship. This danger can be lessened through multi-agency funding or funding from both Government and nongovernment sources. Agency head evaluations should focus particularly on ways to obtain a significant portion of the business of FFRDCs under normal competitive arrangements with both governmental and nongovernmental organizations.

Nonprofit Research Institutes

In a 1969 survey, the National Science Foundation identified 159 nonprofit institutes that primarily performed research and development in the natural and social sciences. The three major research institutes (see table 5) account for 37 percent of the $361 million in expenditures for R&D by these organizations.[9] Of this $361 million, 62 percent was financed by the Government, 20 percent by industry, seven percent by the institutes' own funds, one percent by State and local governments, and the balance by other sources.[10]

In 1969, nonprofit organizations collectively constituted a very small (slightly over five percent of the Federal R&D budget) resource in comparison to other sources.[11] However,

[8] U.S. Congress, House, Committee on Appropriations, *Department of Defense Appropriation Bill 1972*, H. Rpt. 92-666, 92d Cong., 1st sess., Nov. 11, 1971, pp. 106, 110, 116, and 121. (Percentage calculated by the Commission.)

[9] National Science Foundation, *Scientific Activities of Independent Nonprofit Institutions*, 1970, Report 71-9, pp. 7 and 38.

[10] *Ibid.*, p. 38 (percentages calculated by Commission).

[11] *Ibid.*; and *Special Analysis, Budget of the U.S. FY 1971*, p. 266 (percentage calculated by the Commission).

TABLE 5. MAJOR INDEPENDENT RESEARCH INSTITUTIONS, TOTAL SALES, 1969
(Millions of dollars)

Institute	*Sales*
Stanford Research Inst. Menlo Park, Calif.	54.2
Battelle Memorial Inst. Columbus Laboratories,* Columbus, Ohio	46.9
Cornell Aeronautical Lab.** Buffalo, N.Y.	32.5
Total	133.6

*Battelle's Pacific Northwest Laboratories, not listed here, functions both as an independent research institute and as the operator of an FFRDC.

**Recently converted to the profit sector as Calspan Corp.

Source: National Science Foundation, *Scientific Activities of Independent Nonprofit Institutions*, NSF 71-9, 1970, p. 7 and 38. (Volume calculated by the Commission.)

their importance is far greater if their work in basic and applied research is considered. Although efficiency due to the profit motive, tax base considerations, or competition do not normally apply to this category of resources, the nonprofit organization offers flexibility of operations (particularly in personnel policies), objectivity due to absence of profit or product bias, and ability to attract and hold a high level of scientific and technical talent.

Nonprofit institutions have shared with universities the difficulties caused by cost sharing on R&D projects. In addition, Government agencies tend to pay lower fees to them than to other contractors. Some Internal Revenue Service interpretations of the tax laws lean toward taxation of income earned by independent research institutes, including income from Government-sponsored research. Certain provisions of the Tax Reform Act of 1969 suggest further constraints on the funding capacities of these research organizations that will deter them from bidding on large Government projects. The nonprofit community feels that Government procurement rules and procedures do not recognize them as a separate class of organization with unique characteristics and problems. The special problems of nonprofit R&D institutions deserve attention.

Academic Institutions

The academic institutions include colleges, universities, schools, institutes of technology, and other professional organizations that couple academic responsibilities with R&D programs. Table 6 shows the past and present extent of Government reliance on universities for R&D effort and agency expenditures from fiscal 1960 to fiscal 1973.

TABLE 6. FEDERAL R&D OBLIGATIONS TO UNIVERSITIES AND COLLEGES
(Millions of dollars)

	Fiscal Years													
Agency	*60*	*61*	*62*	*63*	*64*	*65*	*66*	*67*	*68*	*69*	*70*	*71*	*72*	*73*
HEW	158	221	310	350	419	473	534	620	671	695	647	698	821	895
DOD	155	191	200	238	292	291	295	280	244	263	215	196	194	205
NSF	60	68	89	115	127	142	187	208	221	213	228	254	354	415
NASA	10	18	54	78	106	124	133	124	131	125	131	97	112	117
AEC	39	49	55	67	69	74	82	90	93	101	100	90	85	85
Agriculture	32	33	39	41	49	58	62	64	61	62	65	72	84	90
OEO	--	--	--	--	--	7	21	16	14	25	20	9	10	7
Interior	2	2	3	4	6	10	20	23	26	24	19	20	24	28
DOT	0.3	0.7	0.7	0.8	0.6	0.4	1.4	11	12	13	11	8	11	19
AID	0.1	0.3	3	1	4	6	4	3	4	5	8	13	16	22
Labor	--	--	0.1	0.5	1	2	3	3	3	3	4	2	2	3
HUD	--	--	--	--	--	--	0.4	3	1	1	1	1	1	1
Commerce	1	1	2	3	3	4	4	6	7	2	5	15	19	39
Other	2	1	1	1	2	2	4	4	3	5	20	18	25	23
Total	459.4	585	756.8	899.3	1078.6	1193.4	1350.8	1455	1491	1537	1474	1493	1758	1949

Source: York, "Steps Toward a National Policy for Academic Science," *Science*, vol. 172, May 14, 1971, p. 644. (Fiscal 60–68). National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1969, 1970, 1971*, NSF 70-38, vol. XIX, pp. 118–119;—*Fiscal Years 1970–1972*, NSF 71-35, vol. XX, pp. 92–93;—NSF appendixes C & D, statistical tables, vol. XXI, tables C–10, C–11, C–12 (not yet published). NOTE: Data rounded by Commission.

Government agencies predominantly use universities for basic research (in contrast to applied research or development), since this effort most readily correlates with instruction and individual projects by faculty and graduate students. Approximately half of the total (47–48 percent in fiscal years 1969–1972) Federal obligations for basic research were expended by universities and colleges and by FFRDCs administered by universities.[12]

The benefit to the Nation of supporting graduate education and enhancing the technological base warrants consideration. Many recent studies [13,14] indicate that "the quality of one major part of an institution is shared by the entire institution. Both Federal research funding and total non-Federal funding are thus correlates of graduate educational quality."

In recent years the extent of agency reliance on academic institutions for development of scientific manpower and basic research has caused problems for these institutions. Along with their other financial problems, universities have faced restrictions in funds available for basic research, long-range advanced studies, and scientific training. The increasing numbers of agencies involved in Federal R&D has meant growing confusion in the selection of appropriate mechanisms to fund basic research and training in universities. This occurs particularly if the agency procurement offices are more familiar with commodity procurement techniques (for example, sealed bid) not well suited to the procurement of R&D or training.

The spread of agency R&D program responsibilities also has increased the diversity of practices and caused confusion in the academic community regarding the administration of R&D contracts and grants. Although BOB Circular A–88 established cognizant agency responsibility for indirect cost rates and auditing for grants and contracts with educational institutions,[15] greater consistency could be achieved if cognizant agency responsibility were established for other aspects of contract and grant administration at universities (for example, negotiation of master agreements).

Agency attitudes regarding cost sharing cause problems for the academic community. The various legislative and administrative restrictions that impose cost sharing on university performers add to their financial distress and decrease their ability to initiate R&D efforts (see Chapter 4).

INDUSTRY

Industrial performers dominate Federal R&D. In 1968, about 70 percent of the Nation's scientists and engineers working in R&D were employed in industrial laboratories.[16] Funding of these laboratories in 1970 accounted for more than 70 percent of the Nation's total R&D expenditures from Federal and other sources.[17] During fiscal 1968, 49 percent of all R&D funding for industrial performers came from the Government,[18] of which 63 percent was from DOD, 27 percent from NASA, and 10 percent from all other agencies.[19]

During fiscal 1971, industrial firms accounted for about 59 percent of total Federal R&D funding.[20] During the same period, industry accounted for 87 percent of the Government's total participation in development efforts.[21] Industrial contracts increased rapidly during 1955–1967 in response to DOD's need for weapons buildup and NASA's technological developments. After a peak of $8.6 billion in fiscal 1968,[22] Federal funding of industrial R&D declined to $7.7 billion in fiscal 1971,[23] although increased levels are expected for fiscal 1972.[24]

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[12] Calculated by the Commission from data in NSF Report 71–35, vol. XX, p. 9.

[13] U.S. Department of Health, Education, and Welfare, *Report on Higher Education*, Task Force Report, Mar. 1971.

National Science Foundation, *Graduate Education, Parameters for Public Policy*, report prepared for the National Science Board, NSF, 1969.

[14] National Science Foundation, *Toward a Public Policy for Graduate Education in the Sciences*, report of the National Science Board, NSF, 1969.

[15] U.S. Bureau of the Budget, Circular A–88, *Policies for Coordinating the Determination of Indirect Cost Rates and Auditing in Connection with Grants and Contracts with Educational Institutions*, May 15, 1968.

[16] National Science Foundation, *National Patterns of R&D Resources, Funds and Manpower in the United States, Fiscal Years 1953–1970*, NSF 69–30, Sept. 1969, p. 12.

[17] *Ibid.*, p. 4.

[18] National Science Foundation, *Research and Development in Industry, 1968*. NSF 70–29, Jan. 1969, p. 6.

[19] *Ibid.*, p. 8.

[20] Calculated by Commission from data in *National Patterns of R&D Resources, etc., 1953 thru 1971*, NSF Rpt. 70–46, Dec. 1970, p. 29.

[21] Calculated by Commission from data in *Ibid.*, p. 35.

[22] *Ibid.*, p. 29.

[23] Note 1, *supra*, p. 23.

[24] *Ibid.*

CONSORTIA

The trend toward increasing interdependence of agencies is a consequence of the increasing complexity and costs of R&D. Programs and projects have been developed that transcend the usual disciplinary or departmental boundaries of sciences or institutions to achieve progress in certain areas, particularly in the social sector.

Recommendation 6. Monitor the progress of the NSF/NBS experimental R&D incentives program and actively translate the results of this learning into practical agency application.

There has been an increasing need for improved interaction between institutions and organizations to accomplish special goals. To respond to these needs, consortia of interacting institutions have been formulated. These organized consortia are a significant mechanism in the administration of some of AEC's national laboratories (for example, Associated Universities, Inc.). They also have provided mechanisms for expediting research in clinical areas (for example, Cooperative Research for Cancer Therapy at NIH).

In order to help develop industrial fields or provide resources for the entire national R&D community, multi-institutional efforts are expected to increase in coming years. Multi-institutional organizations may consist of members from the same broad communities (for example, industrial or academic) or a mix of several types of performers (for example, academic, industrial, and nonprofit), depending on the requirements of the activity to be supported. Multi-institutional organizations might create new problems, such as how to interpret antitrust laws and patent policies when industrial organizations are involved, and how best to administer these programs.

The experimental research programs of the National Science Foundation and the National Bureau of Standards support, on a matching fund basis, specific industry or academic consortia to: (1) advance that industry's or discipline's scientific knowledge or technological competence; (2) develop and operate major scientific, experimental, or testing facilities or complexes available to all at a reasonable user charge; or (3) develop and operate major, unusual industrial facilities available to all at a reasonable user charge. The results of this program should be closely examined and promptly used in developing future policy.

CHAPTER 4

Procurement Policy

Innovation, creativity, originality, and imagination are the essence of R&D. These special factors are prime considerations in the development of policies and procedures for R&D procurement. Through R&D the Government seeks new ways to attain stated national goals, whether these be individual agency missions, broad interagency goals, or long-range national objectives.

Uniform Regulations for R&D Procurement

Greater uniformity is needed among agency regulations governing the procurement and administration of R&D. A more consistent approach within a framework that accommodates the special needs of affected agencies should help sponsors and performers to operate more simply and effectively. Part A, Chapter 4, deals with the problem of removing inconsistencies among existing agency procurement regulations. Action is particularly needed to improve policies and procedures governing such aspects of R&D procurement as cost sharing, use of unsolicited proposals, techniques for stimulating R&D innovation and investment of private venture capital, and treatment of IR&D and B&P expenditures.

Federal R&D procurement policy is influenced by many rules, notably provisions in applicable statutes, procurement regulations, circulars, and other instructions from OMB, and various agency policies and procedures. Defense and certain other agencies are subject to the Armed Services Procurement Act of 1947 (ASPA), but most civilian agencies follow the Federal Property and Administrative Services Act of 1949 (FPASA). However, there is no effective mechanism for coordinating the procurement-related provisions of the various statutes for specific programs.

Unlike the Armed Services Procurement Regulation (ASPR), the R&D section of the Federal Procurement Regulations (FPR) has not been issued. In the absence of FPR guidance on R&D procurement, the civilian agencies (and even bureaus within agencies) have issued their own R&D regulations. Although many agencies have patterned their regulations after ASPR, there has come into being a diverse variety of agency procurement procedures.

Some steps have been taken to provide greater Government-wide uniformity in the administration of R&D grants and contracts.[1, 2] OMB has identified areas of diversity and has tried to standardize R&D procurement policies through its Circular A–21 on cost principles [3] and Circular A–100 on cost sharing.[4] Greater consistency for R&D procurement procedures is fostered also through such issuances as Circular A–88 on indirect costs and audit determinations,[5] and Circular A–101 on administration of research grants and contracts.[6]

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[1] U.S. Bureau of the Budget, *The Administration of Government Supported Research at Universities*, Mar. 1966.

[2] U.S. Bureau of the Budget, *Report on the Project Concerning the Policies, Procedures, Terms and Conditions Used for Research Projects at Educational Institutions*, June 20, 1969.

[3] U.S. Office of Management and Budget, Circular A–21 (revised), *Principles for Determining Costs Applicable to Research and Development and Educational Services Under Grants and Contracts With Educational Institutions*, Mar. 30, 1971.

[4] U.S. Office of Management and Budget, Circular A–100, *Cost Sharing on Research Supported by Federal Agencies*, Dec. 18, 1970.

[5] U.S. Bureau of the Budget, Circular A–88, *Policies for Coordinating the Determination of Indirect Cost Rates and Auditing in Connection With Grants and Contracts With Educational Institutions*, May 15, 1968.

[6] U.S. Office of Management and Budget, Circular A–101, *Administration of Grants, Contracts or Other Agreements with Educational Institutions*, Jan. 9, 1971.

OMB's Federal Assistance Review (FAR) Program is continuing to develop procedures for greater interagency uniformity and simplification of funding and administration, including those for R&D. Various other steps have been taken by some agencies toward greater uniformity of practices among their separate R&D procurement offices.

Despite this progress, the diversity of agency R&D practices causes much confusion and misunderstanding over R&D procurement on the part of Congress, the general public, and performer organizations. The latter are particularly concerned about the extra administrative expenses they incur as a result of inconsistencies in R&D procurement practices among and even within the Federal agencies.

Sponsor agencies also admit to the need for greater consistency in Federal R&D procurement policy. They note that special consideration is needed for R&D procurement policy in view of its unique characteristics. Further, and of equal importance, R&D procurement includes participation by three classes of performers, namely, universities, nonprofit research institutions, and Federal Funded Research and Development Centers (FFRDCs), that function to a much lesser extent as suppliers of other types of Federal procurement.

While greater consistency in R&D procurement is generally desired, some degree of interagency variation must be expected within guidelines established as national R&D procurement policy. R&D agencies need to maintain a degree of flexibility to accommodate different program purposes and needs and the special relationships they have with mixes of performers. Sound procurement practices generally require and permit flexibility in the exercise of judgment. They should establish the bounds of alternative courses of action within the limits of acceptable practice. Such flexibility is not inconsistent with the need for more uniform R&D procurement policies and regulations.

We conclude that the need and opportunity exist for more uniform procedures which will allow the wide variety of sponsors and performers to work more simply and effectively. The extent of the benefits to be gained makes it important that prompt action be taken to bring about the needed improvements.

We believe that an element of Government disassociated with direct buying responsibilities should be given responsibility for promulgating, administering, and monitoring compliance with R&D procurement policies and regulations. OMB and its predecessor the Bureau of the Budget, have issued several policy circulars specifically directed to various elements in the administration of R&D contracts and grants, and various others on topics relating to R&D activities. OMB is well qualified to become a strong leader in the development of uniform R&D procurement policy, especially since it works so closely with the Office of Science and Technology (OST) and the Federal Council for Science and Technology in the development of overall R&D policies.

We realize that various agency mission responsibilities have led the agencies to develop effective procurement procedures and techniques which could provide valuable assistance in the effort to establish and administer uniform R&D procurement regulations and policies. An effective arrangement would thus provide for permanent working relationships between the office responsible for uniform R&D procurement policies and regulations, and key agencies with particular procurement expertise. This should take the form of designating lead agencies to assist in the initiation and development of appropriate policy and regulations for procurement of various types of programs, for example, basic research and advanced studies, hardware systems, and socially oriented systems.

Negotiation for Procurement of R&D

In Part A, Chapter 3, we recommend that the basic procurement statutes be amended to make competitive negotiation an acceptable alternative to formal advertising. In addition, we recommend that high level approvals of such negotiations no longer should be required.

These recommendations are particularly relevant to R&D procurement. Formal advertising is rarely, if ever, appropriate for R&D contracting and is almost never used. The common baseline specifications essential for formal advertising not only are lacking in R&D procurement, they generally are not de-

sirable. Innovation and creativity, which are the key features of R&D, would be dissipated if specifications for uniform products were prescribed. (See Part C.)

Although both ASPA and FPASA authorize the use of negotiation for R&D contracts, both require a determination and finding (D&F) that formal advertising is not appropriate. Under the ASPA, the D&F must be approved at the Secretarial level for contracts over $100,000; under the FPASA, the D&F for contracts over $25,000 must be approved by the agency head. The FPASA further requires that even negotiated R&D contracts under $25,000 be approved at least by "a chief officer responsible for procurement."

We did not find a single instance where a D&F with respect to R&D was disapproved because use of negotiation was not considered appropriate. The present statutory requirement to justify the use of negotiation results in many unnecessary and perfunctory exercises. In many cases it means the issuance of a request for proposals is held up while the paperwork is processed through organizational echelons up to the requisite approving authority. In addition to the time delay, this process results in a waste of manpower and needless administrative expenses.

In recommending the elimination of D&Fs for contracts awarded through competitive negotiations, we noted in Part A, Chapter 3, that it was desirable to require a written record to be made of the reasons for not using formal advertising in contracts over $10,000. This requirement is superflous in R&D contracts and might well be omitted. In Chapter 3 we also recommended that an authorization to conduct sole-source negotiations should require an approval above the level of the contracting officer under criteria established by the Office of Federal Procurement Policy. This requirement should be retained for R&D procurement.

In some agencies the present statutory D&Fs are used also as a program control and monitoring mechanism. In recommending the elimination of D&Fs we do not suggest that appropriate management controls and reports are not needed; however, we believe other existing and more expeditious management techniques should be used for this purpose.

Unsolicited Proposals

In many instances proposals are submitted not in response to an agency solicitation but at the initiative of the performer who suggests an area or field of effort that he believes will be of interest to the agency. The performer is usually aware of fields of agency interest, either through past communication with the agency, or through general awareness from agency program announcements. If the proposal is unique and promises important benefits that are worth the money, the agency will make a sole-source award to allow the performer to pursue the proposed research. Such proposals are known as "unsolicited proposals."

Recommendation 7. Eliminate restraints which discourage the generation and acceptance of innovative ideas through unsolicited proposals.

Only 13 percent of the Nation's R&D scientists and engineers are employed by Government.[7] It is not surprising, therefore, that the inspiration or key discovery necessary to the solution of Government problems often comes from the private sector. Unsolicited proposals are a primary method by which the Government obtains creative ideas from the private sector for satisfying the Nation's basic and applied research programs.

We found that some agencies use unsolicited proposals in their R&D procurement. However, many do not. Agencies that value unsolicited proposals believe that they generate new approaches to old problems and suggest possibilities for attacking new or yet-to-be-defined problems. Unsolicited proposals provide these agencies an important tool for accomplishing functions not always well served by solicited proposals.

Some agencies that think unsolicited proposals are too troublesome discourage or have even stopped their use. Moreover, some performers claim that agencies tend increasingly to convert unsolicited proposals into RFPs, which are then sent out for competition. Performers generally note fewer successes with unsolicited proposals and correspondingly

[7] National Science Foundation, *National Patterns of R&D Resources, Funds and Manpower in the United States, 1953–1972*, NSF 72-300, p. vi.

more awards in competitive RFP procedures. Finally, OMB Circular A–100 and provisions in certain appropriation acts impose cost sharing on programs resulting from unsolicited proposals (see next section).

The negative treatment of unsolicited proposals has diminished the flow of innovative ideas to the Government and, worse yet, has stifled performer efforts toward submission of creative proposals. Government attitudes at all levels should be changed to stress the value of having external sources of innovative ideas. The common misunderstanding must be corrected that it is somehow better to be able to state the solutions of problems in-house than to accept those submitted from outside.

Cost Sharing

Cost sharing has been defined by the Office of Management and Budget in Circular A–100 as "participation by the performing organizations in the cost of research supported by Federal agencies." [8] Cost matching also is used sometimes to denote a performer's assumption of partial costs for Federally funded activities. In common usage, however, cost sharing connotes relatively minor portions of costs assumed by nongovernmental institutions under individually negotiated agreements, while cost matching refers more often to larger portions of costs (for example, 25–75 percent) assumed by State and local governmental units, following established blanket rules for matching fund determinations.

Recommendation 8. Eliminate cost sharing on R&D projects, except in cases where the performer of the project would clearly benefit, e.g., through economic benefits on commercial sales. Decisions with respect to the placement of R&D contracts or grants should not be influenced by potential involvement in cost sharing.

Cost sharing may be either voluntary or mandatory. Voluntary cost sharing occurs when the performer feels it is in his best interests to share part of the cost of a given project and actively works to establish a joint funding arrangement. Mandatory cost sharing exists when the sponsor requires acceptance by the performer of part of the project cost as a condition for entering into an arrangement.

One of the first statutory requirements for cost sharing was the limitation placed on indirect costs for research grants in the Labor-HEW Appropriations Act for fiscal 1958. This enacted into law the 15-percent limitation previously applied by agency policy.

The statutory indirect cost limit was raised to 20 percent for fiscal 1963, and the Labor-HEW Appropriations Act for fiscal 1966 substituted a clause which has been used each succeeding year:

> None of the funds provided herein shall be used to pay any recipient of a grant for the conduct of a research project an amount equal to as much as the entire cost of the project.

The 1970 Appropriation Act for the Independent Offices and HUD, Public Law 91–126, contains a substitute cost sharing requirement:

> None of the funds provided in this Act may be used for payment, through grants or contracts, to recipients that do not share in the cost of conducting research resulting from proposals for projects not specifically solicited by the Government: provided, that the extent of cost sharing by the recipient shall reflect the mutuality of interest of the grantee or contractor and the Government in the research.

While Senate Report No. 91–521, which accompanied this bill, expressed the hope that the new language "will permit the orderly evolution of administrative regulations to incorporate the new principles," subsequent developments have not brought this hope to realization. Among the major agencies involved, NASA and NSF are governed by the new language, but HEW appropriation bills contain the old language, which is observed also by DOD even in the absence of statutory requirements. AEC also has not been subject to statutory requirements, but has required cost sharing in most of its research support agreements.

The Bureau of the Budget in December 1965

[8] U.S. Office of Management and Budget, Circular A–100, *Cost Sharing on Research Supported by Federal Agencies*, Dec. 18, 1970.

issued Circular A–74 [9] which provided cost sharing guidelines for agencies that issued research grants. Under OMB Circular A–100, issued in December 1970 to replace A–74, mandatory cost sharing is imposed on research contracts as well as grants. While its cost sharing provisions apply to all types of performers, the overwhelming burden of cost sharing is carried by academic institutions since they are the primary performers of basic research.

The rationale for cost sharing derives from the attitude that the *support* of research is philosophically different from *procurement* of research. In the latter case, the Government is guided by the principle that it is prepared to pay the full cost at fair market value of any item it procures to fulfill its mission. In the case of research support, the relationship between Government agencies and private research performers is presumed to include a mutuality of interest which warrants a sharing of the costs of such research.

This line of reasoning leads to the imposition of cost sharing on research grants which are viewed as a support mechanism. It is not imposed on research contracts, except those which result from "unsolicited" proposals, in which the first formal communications on the proposals are from the potential performers to the Federal agency.

Before mandatory cost sharing was imposed, many universities voluntarily contributed significant faculty salary costs to Federally funded research projects. When cost sharing became mandatory, especially after issuance of Circular A–74 in December 1965, costs to Government grants rose from two factors: (1) faculty salary direct costs were included to compensate for those portions of salaries or other costs to be applied toward cost sharing, and (2) increased administrative costs were necessitated by the required reporting systems. As the Comptroller General testified in April 1969, both Government agencies and educational institutions have found that mandatory cost sharing has added to the burden of administering grants by requiring dollar determinations and documentation of participation.[10, 11] The Government R&D procurement process thus suffers from increased performer costs, increased agency administrative costs, and a consequent decrease in the Federal research yield per dollar expenditure. Above all, these restrictions in the system do nothing to increase the total yield of research performed; they merely rearrange it in a bookkeeping fashion, at considerable cost.

An additional consideration is that the unequal enforcement of cost sharing by different agencies, both in kind and in amount, causes confusion in the performer community and creates biases against those institutions which serve the agencies which impose most intense sharing requirements. For instance, a university responding to an Office of Naval Research (ONR) program request for proposal will not need to cost share for a certain basic research project, but if the same project were proposed to the National Science Foundation (NSF) or National Institutes of Health (NIH) cost sharing would be required.

Certain circumstances justify the voluntary acceptance of cost sharing or matching, especially when actual or potential benefits to the performers are clear. For instance, grants or contracts may be awarded to profit or nonprofit institutions, or consortia of institutions, primarily to enhance their R&D or technological capabilities. Cost sharing would be justified in such instances. Likewise, certain performers might stand to benefit, directly or indirectly, through actual or potential commercial sales, thus justifying the consideration of cost sharing. While academic institutions benefit, in a sense, from payment of faculty research salaries from Federal research grants and contracts, we do not view this benefit as one generally calling for cost sharing. In many situations the academic institutions must employ others to fulfill the teaching functions from which the research staff is released.

Voluntary cost sharing, however justified, generates nearly all of the same problems as mandatory cost sharing. Therefore, while its

[9] U.S. Bureau of the Budget, Circular A–74, *Participation in the Costs of Research Supported by Federal Grants*, Dec. 13, 1965.

[10] U.S. Congress, Senate, Committee on Government Operations, *Federal Support of Project Grants: Indirect Costs and Cost Sharing*, Hearings before the Subcommittee on Government Research, 91st Cong., 1st sess., Apr.-May, 1969.

[11] U.S. Comptroller General, Report B–117219, report to Congress on a *Study of Indirect Cost of Federally Sponsored Research Primarily by Educational Institutions*, 1969.

use should not be eliminated, it should be controlled. Voluntary sharing should be allowed only when the Government sponsor is aware that the proposal presumes cost sharing, and the sponsor agrees that it is in the Government's interest to accept the proposal. When price competition is a selection factor, the sponsoring agency should (a) ascertain that the sharing proposals are truly voluntary and not suggested from within the agency, and (b) examine the motivation underlying the proposal and arrange for evaluation at an echelon higher than that of the procuring official.

Cost Recovery

We analyzed two kinds of situations in which the Government seeks to recover part of its costs for R&D from commercial firms that benefit from the results of Government-sponsored work. The first of these involves cost recovery from resulting commercial sales of new products. The second concerns cost recovery from foreign military sales.

Recommendation 9. Eliminate recovery of R&D costs from Government contractors and grantees except under unusual circumstances approved by the agency head.

R&D COST RECOVERY FROM COMMERCIAL SALES

The Federal Aviation Administration (FAA) in the Department of Transportation (DOT) has been using a clause which provides that if a commercial product results from an R&D contract which furnishes a product as an end item, the Government will recover a portion of its R&D expenses in the form of royalties on the contractor's sales, when the product is sold profitably.[12] The DOT contract clause provides that the contracting officer will determine a fair, reasonable, and equitable amount which the contractor shall pay, up to 5 percent of commercial sales or lease income. The DOT policy also requires that contractors pay the Government up to 33 percent of sums received as payments under technical agreements permitting others to sell, lease, or manufacture the product. Recovery by the Government is limited to amounts paid and credited to the contractor under the specific contract. DOD has a flexible policy of recovering nonrecurring costs in the form of an assessment on commercial sales, when research, development, test, and evaluation expenses exceed $25 million, or when total production expenditures are estimated to exceed $100 million.[13]

Questions have been raised as to the rationale for the DOT and DOD policies, and as to whether the recouped costs yield a return which justifies the administrative efforts and expense involved and whether the return is sufficient to compensate for potential loss of tax revenue. Although our studies focused primarily on the DOT situation, the findings are generally equally applicable to the DOD policy, and the conclusions reached should be applicable to the R&D procurement policies and practices of other agencies as well as to DOD and DOT.

The DOT cost recovery program is based, first, on the established Government policy that, where a direct beneficiary of a Government action can be identified, that beneficiary and not the general taxpayer should pay the cost of providing the benefit conferred. This program returns R&D costs to the general taxpayer from the beneficiaries of Government R&D funding: the consumer and the company making the commercial sales.

A second justification offered for the program is the need to prevent favoritism toward incumbent contractors. When the Government supports the development of a commercial product, the company that gets the development contract is given an advantage over its competitors who might have to develop a competing product with their own funds.[14] The contractor funded by the Government could be in a position to make an extraordinarily high profit, to undersell his competitors, or even to prevent them from entering the market. (This justification assumes little additional effort required by the developing

[12] U.S. Department of Transportation, *Procurement Regulations;* see *Federal Register*, vol. 37, no. 44, pt. II, subpart 12-9.62, Mar. 4, 1972, p. 4875.

[13] ASPR 4-110 and 7-104.64, Aug. 1969.

[14] Note 12, *supra.*

contractor to adapt the concept to the commercial market, a situation which seldom exists.)

In examining DOT's experience with the cost recovery clause, we found that FAA included the clause in more than 180 contracts as of the time of our study. Total cost recovery as of June 1970, the latest data available to Commission studies, was approximately $175,000.[15] Recovered funds are paid to the U.S. Treasury as miscellaneous revenues. Data were not readily available as to the total R&D cost potentially recoverable where the clause has been used because, according to FAA, there are too many variables, chief of which is the impossibility of predicting profitmaking sales.

Apparently the DOT clause is intended to be equitable to all parties, both in concept and in practice. Based on the small amount recovered to date, one may surmise that no major programs have been subject to recoupment. In contrast, if the supersonic transport contract had not been canceled and if the resultant aircraft had been commercially successful, the venture would have returned major revenues to the Treasury.

Our studies revealed concern about several effects of the cost recovery program from both short and long-range viewpoints of Federal R&D procurement. One factor is that commercial products are likely to result from Federal R&D programs only infrequently and that the program does not offer sufficient potential cost recovery to warrant its broad application.

Another matter of concern is the hesitance of potential performers to undertake Federal R&D because of insufficient opportunity for commercial exploitation. The restrictive attitudes of some agencies regarding patent rights cause some R&D performers to conclude they cannot justify investment in startup, production, and marketing costs. Requirements for recoupment of R&D costs would certainly be a further disincentive to the participation of some performers and an impairment to the eventual availability of the results of Government-sponsored technology in the marketplace. Actually, such assessments against the successful innovator appear to handicap the successful introduction of new technology without necessarily providing any redeeming fairness of treatment to his competitors. What appears necessary is to seek the earliest practicable and widespread use of technological improvements.

A recent DOT-NASA study of civil aviation R&D policy [16] points to additional and growing areas of concern. Federal sponsorship of aviation R&D began to increase significantly before World War II when it was realized that the United States was falling behind European countries in aircraft technology. Recent superiority of the U.S. aircraft position in the world market has been due in large part to the considerable bank of R&D data available at the end of World War II, which the commercial aircraft and component manufacturers were able to exploit quickly and economically into commercial products. Superiority of U.S. commercial aircraft products was stimulated also by the domestic competition among the major U.S. aircraft manufacturers for the U.S. airline market and by the "package" approach to overseas sales of U.S. aircraft.

Foreign concerns and governments now seek to become less dependent on the United States for commercial and military aircraft and also to gain a significant share of the U.S. market. In efforts to capture world aviation markets, they are now concentrating greater technical, financial, and political resources toward offering the same "package" procurements as U.S. manufacturers. In some instances they are outbidding U.S. concerns, particularly with conditions for favorable financing. As a result, the U.S. aircraft industry faces the prospects of a significantly smaller share of the world market.

These considerations demonstrate that the United States can no longer be complacent about presumed technical superiority in the international competition for markets. While the paragraphs above describe the situation in the aircraft industry, the same difficulties are faced by other high-technology industries in the United States, such as electronics and computers, which are faced with increased com-

[15] Letter from the Director of Installations and Logistics, Department of Transportation, to the Commission, May 5, 1971.

[16] U.S. Department of Transportation and National Aeronautics and Space Administration, *Joint DOT-NASA Civil Aviation Research and Development Policy Study*, DOT TST-10-5 and NASA SP-266, supporting papers, Mar. 1971.

petition from foreign companies, many of which benefit from support and stimulation by their own governments (see Appendix D). There is a need for a determined, cooperative effort involving Government and industry in the United States to maximize the competitive position of U.S. suppliers and, above all, the need for removing impediments to the early application of R&D results for commercial purposes.

The motives underlying the cost recovery program are fair and reasonable. Nonetheless, we believe the Government should stimulate commercial exploitation of technology resulting from Government sponsored R&D rather than impede it. Such stimulation would improve the competitive position of U.S. suppliers in both domestic and international markets and, therefore, is in the public interest. We conclude that cost recovery should be sharply limited to unusual and very expensive programs such as the supersonic transport project.

R&D COST RECOVERY FROM FOREIGN MILITARY SALES

We have examined the effects of the DOD cost recovery policy which requires contractors to return to the Government some portion of nonrecurring costs when major defense equipment is sold to foreign buyers. Nonrecurring costs include "research, development, tests, evaluation, production engineering, product improvement, destructive testing, pilot model production, testing and evaluation." [17]

The regulation is based on a decision by the Secretary of Defense in 1964 that foreign or commercial customers for defense items produced or developed at Government expense should pay the same cost as that paid by the Government. The policy was first implemented by the Air Force and became department-wide policy in 1968. The policy is based on the Foreign Military Sales Act [18] which states in part that DOD cannot sell for less than full value to other countries or international organizations. This act implies that nonrecurring costs and prior development costs are part of the costs of the item and that such costs must be included in the sales price to foreign nations.

Congress has continued to ask whether R&D costs are being recouped through the sales prices, and DOD has assured Congress that such costs are being recovered. DOD has interpreted the act to require recovery. In accordance with this interpretation, DOD reviews and normally includes in the sale price development and related costs for the prior ten-year period if the total system or item had nonrecurring costs of more than $25 million. Recovery of nonrecurring costs also is required if the system cost exceeds $100 million.

The General Accounting Office is now reviewing DOD implementation of the policies for recoupment from foreign military sales and is trying to determine circumstances and conditions when recovery of nonrecurring costs may or may not be justified. GAO has not yet reported the results, nor have total amounts of recoveries been made public.

In September 1970 the Council of Defense and Space Industry Associations (CODSIA) asked the Deputy Secretary of Defense to reconsider and revise the policy on recoupment of nonrecurring costs.[19] CODSIA contends that, based on industry experience with application of the policy, it does not serve the interests of the United States in the current international and domestic sales environment. DOD has acknowledged that implementation of the policy has been cumbersome, time consuming, and sometimes frustrating to those who are responsible for foreign sales.

The entire question of the price to be attached to armaments and other defense equipment to be sold to a foreign nation is secondary in importance to political and strategic considerations. When the policy was conceived, the U.S. Government's sales office pointed out that arms sales contributed to the collective security, permitted better logistical cooperation among allied nations, and helped the balance of payments problem as a partial offset to the cost of U.S. personnel stationed overseas. Early policy, which apparently has continued, was

[17] ASPR 4–110 and 7–104.64, Aug. 1969.

[18] U.S. Congress, House, *An Act to Consolidate and Revise Foreign Assistance Legislation Relating to Reimbursable Military Exports,* Public Law 90–629, 90th Cong., 2d sess., H.R. 15681, Oct. 1968 (popularly cited as the Foreign Military Sales Act).

[19] CODSIA letter to the Deputy Secretary of Defense, Sept. 1, 1970.

that the United States would not sell military equipment to any country that could not afford to pay for it nor to any nation nor block of nations that did not have a legitimate need for such weaponry. The question of meeting the needs of newly emerging nations also came into focus.

Concerning the R&D environment and R&D procurement, the effect of the DOD policy probably is negligible. Further, the effective transfer of technology into consumer products does not appear to be at issue. Actually, in the case of military equipment sales, foreign customers are interested only in purchasing proven and dependable hardware. Technology paid for as "nonrecurring cost" has already been applied, and the resulting product has been made available in quantity to satisfy the customer's needs.

In instances where broad national policies permit foreign military sales, it is important to note that industry considers that the DOD procedure is too slow to permit effective competition in the international market. Foreign sales of armaments and other defense equipment are carefully controlled and subject to approval and license by several agencies in addition to DOD. Under such conditions U.S. industry, operating in a high-labor-cost, capital-intensive situation, finds it increasingly difficult to compete with foreign suppliers who have flexible government support.[20] The present policy is insensitive to balance of payment problems, to domestic employment, and to other national economic considerations.

Independent Research and Development

The treatment of independent research and development (IR&D), bid and proposal (B&P), and other technical effort (OTE) costs has become a very controversial and often emotional subject, particularly in recent years. The emotion and controversy arise from the fact that many Government procurements cannot be satisfied using a sealed-bid, fixed-price technique. When this technique can be used, costs included in the quoted price usually are not questioned and the competitive situation automatically controls the amount of reimbursement for direct and indirect costs. However, in many Government procurement situations the typical characteristics of the commercial, price-competitive market do not completely apply, and the amount of cost reimbursement is an open question. These situations may arise when the Government is the only buyer of specialized products and services not available in a competitive marketplace.

The necessity of cost constraints in this specialized product marketplace has led to the development of "substitute" controls to replace those inherent in the price-competitive environment. The application of one of these "substitute" controls—cost principles to govern reimbursement of direct and indirect costs in the cost-type environment—is essentially the problem relative to the recovery of IR&D, B&P, and OTE costs.

On the average, the indirect costs of IR&D, B&P, and OTE represent less than four percent of total sales;[21] other indirect costs such as occupancy costs or executive management costs sometimes exceed the IR&D and B&P figure, yet are rarely subjected to the same scrutiny and control accorded IR&D, B&P, and OTE. Largely as a result of poor communication and misunderstanding, a specific element of indirect costs has been expanded into a subject of apparent major proportions.

Recommendation 10. Recognize in cost allowability principles that independent research and development (IR&D) and bid and proposal (B&P) expenditures are in the Nation's best interests to promote competition (both domestically and internationally), to advance technology, and to foster economic growth. Establish a policy recognizing IR&D and B&P efforts as necessary costs of doing business and provide that:

(a) IR&D and B&P should receive uniform treatment, Government-wide, with exceptions treated by the Office of Federal Procurement Policy.

(b) Contractor cost centers with 50 percent or more fixed-price Government contracts and sales of commercial products and services should have IR&D and B&P accepted as an overhead item without question as to amount. Reasonableness of costs for other contractors

[20] *Government Executive*, Sept. 1972, pp. 39–45.

[21] Table 2, *infra*.

should be determined by the present DOD formula with individual ceilings for IR&D and B&P negotiated and trade-offs between the two accounts permitted.

(c) Contractor cost centers with more than 50 percent cost-type contracts should be subject to a relevancy requirement of a potential relationship to the agency function or operation in the opinion of the head of the agency. No relevancy restriction should be applied to the other contractors.

The generally acceptable definition of IR&D is that research and development effort which is not sponsored by a contract, grant, or other arrangement. A corollary definition of B&P is that effort resulting in costs incurred in preparing, submitting, and supporting bids and proposals (solicited or unsolicited) for potential contracts. Both of these types of technical effort are undertaken at the initiative of the contractor, with the primary motivations being the regeneration of his technological base and the maintenance and improvement of his competitive capacity.

The types of technical effort in IR&D and B&P often are similar; they are distinguished by the purpose for which the work is being conducted. IR&D is conducted to maintain or advance the technological capability of the company, whereas B&P is conducted to convince the buyer that the company is the most capable supplier for a particular need. Major benefits to the Government are the availability of competent, competitive sources and the advancement of the technology base. An indirect benefit to the Government is the possible increased revenues from the economic growth of the Nation, both internally and in the foreign market. OTE is simply a catchall term used by DOD and NASA to cover a variety of types of independent technical effort (for example, systems and concept studies) undertaken by industry under various names which, for one reason or another, have not been classified as either IR&D or B&P. Historically OTE has been much smaller than either B&P or IR&D in total annual dollar amount.

IR&D and B&P are perplexing issues because, while nearly everyone agrees that both are legitimate cost elements of doing business, great controversy arises over the break points between legitimacy and illegitimacy with respect to Government recognition of these costs for reimbursement. The main issues involved are:

- *Definition/Treatment of Elements.* The need for clearcut definitions of what should constitute IR&D, B&P, and OTE and whether they should be treated as separate entities or in combination
- *Relevancy.* The need for, or desirability of, a relevancy test being applied to the contractor's IR&D/B&P efforts
- *Uniformity.* The need for, or desirability of, uniformity among agencies of IR&D/B&P policies and/or procedures to assure equity of treatment of all contractors
- *Costs.* The need for explicit guidance on composition of costs and the allocation of these costs to specific cost objectives
- *Reasonableness.* The need for an equitable method of establishing the amount of such costs, while recognizing the varying market environments.

BACKGROUND

The allowance of these types of independent technical effort in negotiated contracts was first documented in August 1949. Treasury Decision (TD) 5000 was published which included cost principles to determine allowability of costs for cost-reimbursement-type contracts. Independent technical effort was recognized as an allowable cost.

At that time, independent technical effort was largely devoted to product development rather than to research. The Armed Services Procurement Regulation (ASPR), first published on March 1, 1949, replaced TD 5000. Section XV of ASPR on cost principles disallowed "general research" unless specifically provided for in the contract.

A wide range of interpretations resulted from the ASPR cost principles. In particular, an interpretation arose which allowed independent development but did not allow independent research. This restriction was often circumvented by adding a clause to contracts authorizing reimbursement of research costs. In some cases, separate agreements for IR&D were negotiated which applied across the board to all Government contracts received by a

given contractor; B&P expenses generally were accepted.

As a result of the criticism and confusion resulting from these initial cost principles, a complete revision of ASPR Section XV was issued in November 1959. The revised principles defined "research" and "development" and treated them separately. Independent research costs were generally allowable if allocated to all the contractor's business, and development costs were allowable if directly related to those product lines for which the Government had contracts. Guidelines for technical evaluation of these costs were stated in DOD Instruction (DODI) 4105.52.

During the 1960's many problems arose regarding the 1959 cost principles. There was concern over the separation of "research" and "development," differentiation between IR&D and B&P, technical evaluation associated with advance agreement negotiations, and the application of overhead to IR&D and B&P. A DOD Task Group, under the leadership of the Office of the Director of Defense Research and Engineering (ODDRE), was organized in the early 1960's to address the problems resulting from the 1959 cost principles.

The major recommendation of this Task Group was to identify IR&D, B&P, and OTE collectively as contractor independent technical effort (CITE) and to lump all costs into one pool with a proposed procedure to achieve a negotiated ceiling. The planned first step was to modify the cost principles to combine IR&D and B&P into CITE, improve definitions, and establish a policy of applying overhead to CITE. This effort was to be followed by a determination of "reasonableness," with consideration of "Contractor Weighted Average Share in Cost Risk" (CWAS) and the development of industry norms. This effort continued until late 1966 when the Secretary of Defense terminated it on the basis that IR&D and B&P were generated for different purposes and therefore should be treated separately.

The Office of Assistant Secretary of Defense (I&L) then assumed responsibility and initiated plans to revise the cost principles. This effort, after considerable consultation with industry associations, other agencies, and the Industry Advisory Council (IAC), culminated in revisions to ASPR in 1969 which placed tighter controls over the separation of IR&D and B&P, utilized the CWAS concept, and provided a formula technique for all others.

Criticism in Congress reached crucial proportions in 1969. A Senate bill (S.3003) would have forced DOD and NASA to adopt the AEC criteria for allowability, that is, acceptance only if relevant to a particular contract. An amendment was also introduced to the 1970 Military Procurement Authorization Act to establish a total dollar ceiling on all IR&D, B&P, and OTE supported by DOD. The result of these actions was section 403 of the 1970 Military Procurement Authorization Act which limited the recovery of IR&D, B&P, and OTE to 93 percent of that which would normally be allowable.

GAO conducted a study of IR&D, the results of which were released by the Comptroller General on February 16, 1970 (B–164912). The basic recommendations and alternative suggestions were to (1) have a Government-wide policy, (2) have better administration to avoid duplication, (3) undertake a study to determine whether the Government should receive royalty-free license rights to inventions, (4) adopt CITE, (5) identify the amount of IR&D in Government appropriation requests, (6) consider replacing IR&D by contract or grant where possible and authorize allowance for a percentage of the remainder of the contractor's IR&D effort as a profit factor or through acceptance as a recognized overhead cost, thus providing an incentive to contractors to continue technical efforts beyond those directly contracted with the Government, and (7) consider also providing financial support to capable companies which do not hold Government contracts.

Extensive hearings on IR&D were held in February, March, May, and June 1970 by the Senate Armed Services Committee in relation to the 1971 DOD Military and Procurement Authorization Bill. Section 203 of the 1971 Act repealed the 93-percent limitations of the 1970 Act but added further restrictions on allowability of IR&D and B&P. These restrictions consisted of "a relevancy test" for DOD contracts of "a potential relationship to a military function or operation" and mandatory advance agreements for contractors who re-

ceived more than $2 million for IR&D and/or B&P under noncompetitive contracts. Based on this action and the continuing study by DOD, further revisions to the ASPR cost principles were prepared and issued as Defense Procurement Circular (DPC) 90, September 1, 1971. These changes went into effect on January 1, 1972. Appendix B is a summary of DPC 90.

STATISTICAL DATA

The following data concerning the size and the relationship of IR&D, B&P, and OTE are presented in order to place these cost elements in perspective.

Table 1 and figures 1 through 3 show the yearly size of each cost element since 1963, in three aspects (1) total cost incurred by the contractors, (2) DOD decision of what the contractors should spend and could recover in overhead (amount accepted), and (3) the amount of "should spend" which could be recovered in DOD contracts (DOD share). Although there has been a steady increase over the years for each cost element, the emphasis given by the contractors to each element is changing. Using DOD figures for total cost incurred, B&P costs as a percent of IR&D costs have been declining—from 60 percent in 1963 to 51 percent in 1968.[22] OTE has experienced a similar decline. The reasons normally given for the overall increases in each of these cost elements are the gradual application of department overhead. The relative increase in IR&D over B&P and OTE has generally been attributed to the increasing technological demands of the marketplace.

Table 2 and figure 4 relate these three cost elements and their totals to sales, both total sales and sales to DOD only. It is interesting to note that the distributions in figure 4 are very similar to those on figures 1 through 3 indicating an apparent relationship to sales of independent technical effort incurred and allowed. The last line of table 2 reinforces this observation by showing a relative constant ratio of total costs incurred to total sales. A final point, evident from the data in table 2, is the comparison between the ratio of DOD sales to total sales. Only the B&P costs are reimbursed in an amount such that the two ratios are nearly equal. The IR&D ratio consistently runs 12 to 18 points below the sales ratio while the OTE ratio runs more than 30 points below.

[22] Percentages calculated by the Commission from U.S. Comptroller General, *Allowances for Independent Research and Development Costs in Negotiated Contracts—Issues and Alternatives*, B–164912, Feb. 16, 1970, pp. 86–87.

TABLE 1. DOD SUMMARY OF IR&D, B&P, AND OTE COSTS FOR MAJOR DEFENSE CONTRACTORS (Millions of dollars)

(A = Costs incurred, B = Amount accepted by the Government,[a] C = DOD share)

Year	IR&D			B&P [b]			OTE			Total [c]		
	A	B	C	A	B	C	A	B	C	A	B	C
1963	389	255	197	236	230	178	157	118	84	782	603	459
1964	419	272	199	252	245	182	182	119	71	853	636	452
1965	439	300	198	277	271	186	237	140	76	953	711	460
1966	502	357	224	315	302	202	238	171	91	1,055	830	517
1967	591	439	277	338	325	230	292	163	92	1,221	927	599
1968 [d]	752	572	333	387	372	275	252	126	77	1,391	1,070	685
1969 [e]	808	653	389	426	407	286	178	128	79	1,412	1,188	754
1970 [f]	714	576	347	411	391	275	169	120	73	1,294	1,087	695

[a] Represents amount accepted in overhead negotiations for distribution to all work of the contractors—Government or commercial.
[b] May include nontechnical costs where contractors' records do not segregate such costs.
[c] Represents costs as recorded by the contractors and includes related overhead costs only where the contractors' accounting systems so provide.
[d] Total sales to DOD, $22,275 million; total sales, Government and commercial, $36,954 million.
[e] Total sales to DOD, $22,692 million; total sales, Government and commercial, $36,430 million.
[f] Total sales to DOD, $21,260 million; total sales, Government and commercial, $34,314 million.

Source: (1963–1968) U.S. Comptroller General, *Allowances for Independent Research and Development Costs in Negotiated Contracts—Issues and Alternatives*, B–164912, Feb. 16, 1970, pp. 86–87.
(1969–1970) *Congressional Record*, Mar. 24, 1971, p. S3818 and Memorandum from U.S. Department of Defense, DDR&E, to Commission on Government Procurement, Feb. 7, 1972.

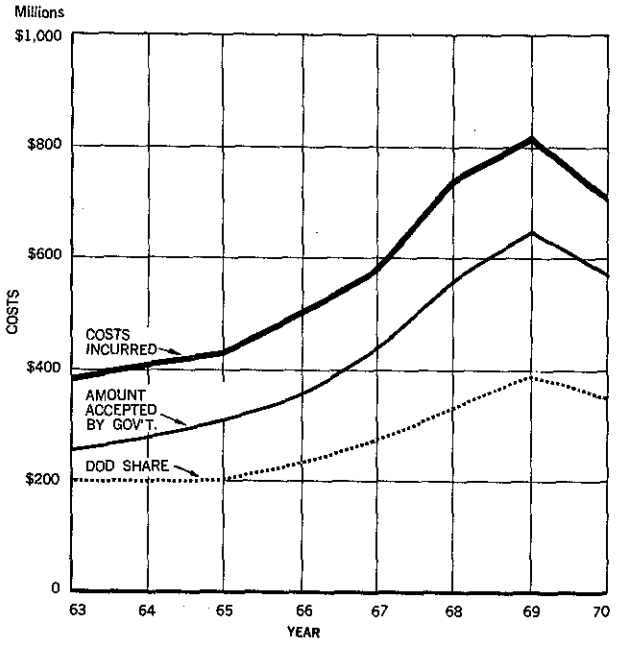
TABLE 2. STATISTICS RELATING TO IR&D, B&P, AND OTE FOR MAJOR DEFENSE CONTRACTORS*
(Millions of dollars)

	1963	1964	1965	1966	1967	1968	1969	1970	1971
Sales									
Total Government and commercial	23,304	23,470	24,054	28,438	34,167	36,954	36,430	34,314	
Total DOD only	17,916	16,442	15,644	17,889	21,371	22,275	22,692	21,260	
% DOD sales to total sales	77%	70%	65%	63%	63%	61%	62%	62%	
IR&D									
Total industry cost incurred	389	419	439	502	591	752	808	714	707
Total reimbursed on DOD contracts	197	199	198	224	277	333	389	347	356
Amount reimbursed on DOD contracts									
As a % of total incurred	51%	47%	45%	45%	47%	44%	48%	49%	50%
As a % of DOD sales	1.10%	1.21%	1.26%	1.25%	1.30%	1.46%	1.73%	1.63%	
B&P									
Total industry cost incurred	236	252	277	315	338	387	426	411	
Total reimbursed on DOD contracts	178	182	186	202	230	275	286	275	
Amount reimbursed on DOD contracts									
As a % of total incurred	75%	72%	67%	64%	68%	71%	67%	67%	
As a % of DOD sales	0.99%	1.11%	1.19%	1.13%	1.08%	1.23%	1.26%	1.29%	
OTE									
Total industry cost incurred	157	182	237	238	292	252	178	169	
Total reimbursed on DOD contracts	84	71	76	91	92	77	79	73	
Amount reimbursed on DOD contracts									
As a % of total incurred	54%	39%	32%	38%	32%	31%	44%	43%	
As a % of DOD sales	0.47%	0.43%	0.49%	0.51%	0.43%	0.35%	0.35%	0.34%	
Grand Total									
IR&D, B&P, OTE incurred	782	853	953	1,055	1,221	1,391	1,412	1,294	
Total reimbursed by DOD	459	452	460	517	599	685	754	695	
Amount reimbursed by DOD									
As a % of total incurred	59%	53%	48%	49%	49%	49%	53%	54%	
As a % of DOD sales	2.56%	2.75%	2.94%	2.89%	2.80%	3.07%	3.32%	3.27%	
Total incurred as a % of total sales	3.36%	3.63%	3.96%	3.71%	3.57%	3.76%	3.88%	3.77%	

Sources: Senate hearings, authorization for Military Procurement Research and Development, Fiscal Year 1971, and Reserve Strength, Committee on Armed Services, 91st Cong., 2d sess., on S.3367 and H.R. 17123, Part 3, Mar. 2, 6, 9, 13, May 7, 12, 19, 27, June 11, 1970, p. 1944.
U.S. Comptroller General, Report B–164912, p. 87.
Memo from the Department of Defense, DDR&E, to the Commission, Feb. 7, 1972, pp. 1–2.
Congressional Record, Mar. 24, 1971, p. S3818.

*Percentage for fiscal years 1968–1970 calculated by the Commission.

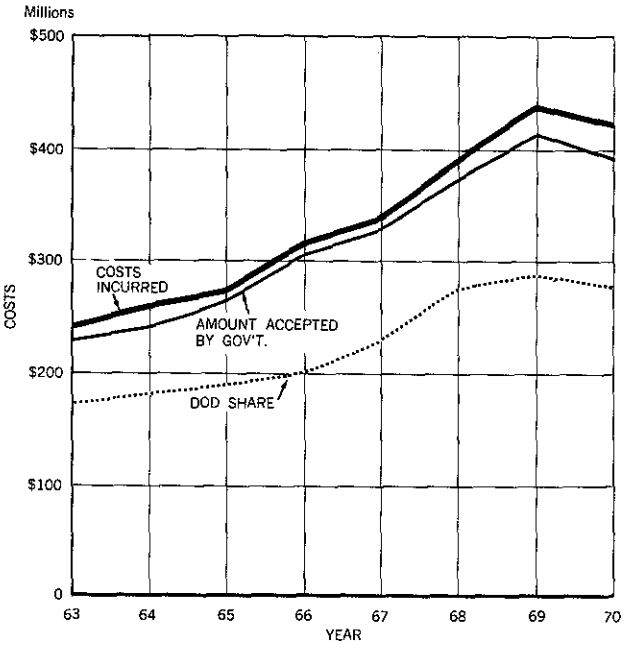
DOD SUMMARY OF IR&D COSTS FOR MAJOR DEFENSE CONTRACTORS



Sources: U.S. Comptroller General, Report to Congress, *Allowances for Independent Research and Development Costs in Negotiated Contracts—Issues and Alternatives*, B–164912, Feb. 16, 1970, pp. 86–87. *Congressional Record*, May 11, 1972, p. S7683. *Congressional Record*, Mar. 24, 1971, p. S3817.

Figure 1

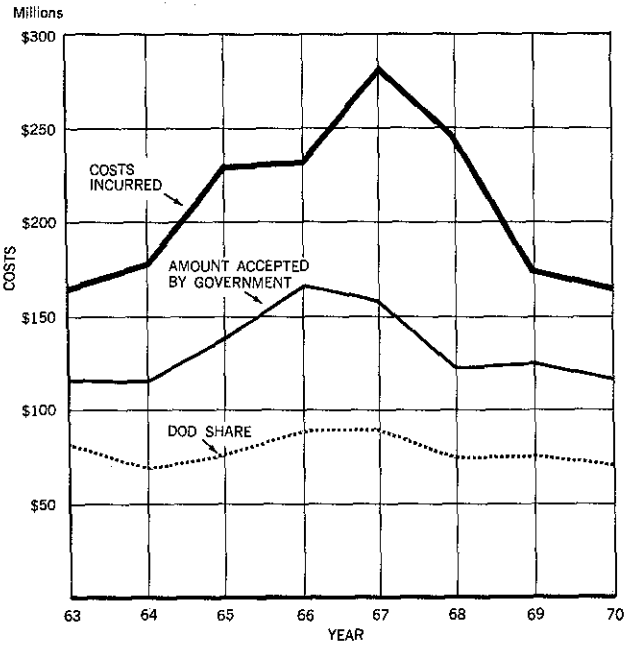
DOD SUMMARY OF B&P COSTS FOR MAJOR DEFENSE CONTRACTORS



Source: Same as figure 1.

Figure 2

DOD SUMMARY OF OTE COST FOR MAJOR DEFENSE CONTRACTORS



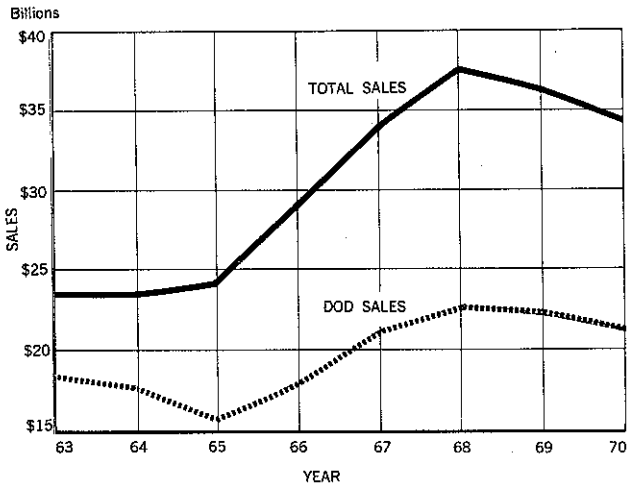
Source: Same as figure 1.

Figure 3

This point is shown in figure 5 which compares the sales ratio with the ratio of total DOD reimbursement to total costs incurred. In 1968, the spread between the ratios ranged between 12 and 18 points. Only in 1969 and 1970 has DOD tended toward reimbursing what appears to be its share based on sales ratio.

Figure 6 shows the ratio of IR&D incurred to total sales for the major defense contractors plotted with the average of similar ratios for comparable high-technology industries with predominant commercial sales. It is evident from the figure that the defense IR&D to sales ratio is well below that of the lowest commercial ratio. This appears to cast some doubt on the argument that defense firms are spending excessive amounts for IR&D in relation to their sales.

DOD SALES AND TOTAL SALES OF MAJOR DEFENSE CONTRACTORS

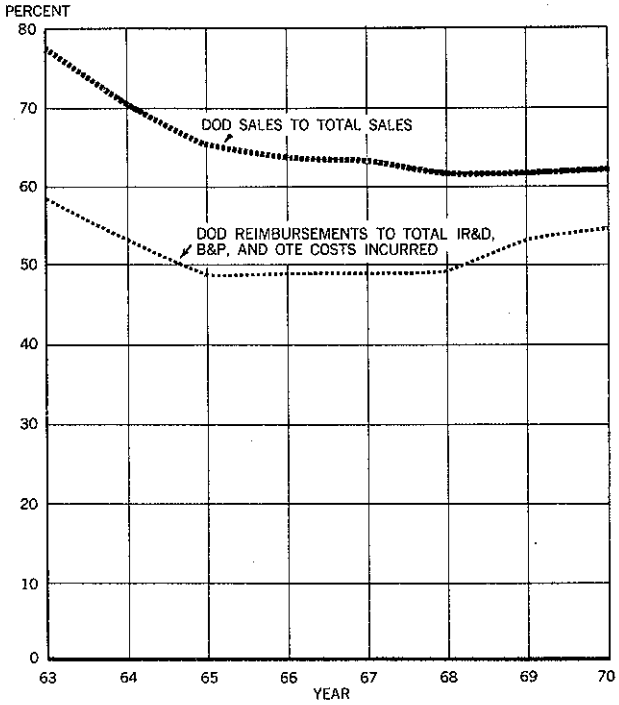


Sources: Senate Hearings, Authorization for Military Procurement, Research and Development, Fiscal Year 1971 and Reserve Strength, Committee on Armed Services, 91st Cong., 2d sess. on S. 3367 and H.R. 17123, Part 3, Mar. 2, 6, 9, 13, May 7, 12, 19, 27, June 11, 1970, p. 1944. Memo from Department of Defense, DDR&E, to the Commission, Feb. 7, 1972, pp. 1–2.

Figure 4

RATIOS OF DOD TO TOTAL SALES AND OF DOD REIMBURSEMENTS TO COSTS

MAJOR DEFENSE CONTRACTORS



Sources: Senate Hearings, Authorization for Military Procurement, Research, and Development, Fiscal Year 1971, and Reserve Strength, Committee on Armed Services, 91st Cong., 2d sess. on S. 3367 and H.R. 17123, Part 3, Mar. 2, 6, 9, 13, May 7, 12, 19, 27, June 11, 1970, p. 1944.
U.S. Comptroller General, Report B–164912, p. 87.
Memo from the Department of Defense, DDR&E, to the Commission, Feb. 2, 1972, pp. 1–2.
Congressional Record, Mar. 24, 1971, p. S3818.

Figure 5

COST CONSIDERATIONS

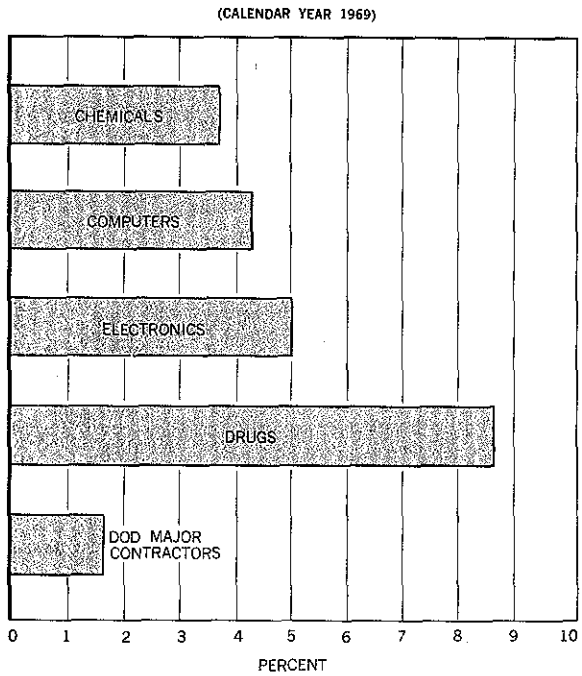
The issue of the composition of IR&D and B&P costs involves the question of whether these costs should just be direct costs or whether they should also include an overhead burden. The departmental (engineering) overhead approaches 100 percent in most high-technology firms, so burdening IR&D and B&P with departmental overhead visibly doubles the amount with no actual increase in man-hours expended. It is this situation which contributes much of the controversy surrounding the composition issue.

Traditionally, IR&D and B&P costs have been allocated as an element of a company's overhead. Recently the growing trend toward tight relevancy restrictions and the magnitude of these costs has lead to a questioning of the traditional allocation and the method of recovery. Proposals for alternate ways of allocating or recovering these costs have been offered from several quarters. The alternative techniques include continuation of recovery through overhead allocation, recovery through profit, and recovery via a direct contract or grant.

Overhead Recovery

It is axiomatic that a business must generate income in excess of all of its costs if it is to survive. A business firm expends funds for payment of the various direct and indirect costs of the business. It defrays these costs, both direct and indirect, in the prices it charges for its products and services. The accounting system of a business is such that the price of each product recovers the direct costs of that product plus an allocable share of the indirect costs (overhead).

AVERAGE R&D EXPENDITURES vs. SALES, BY TYPE OF FIRM



Source: Calculated by Commission from data in *Forbes* Magazine, May 15, 1970. Table 2, *supra*.

Figure 6

When products or services are sold on the commercial market, IR&D and B&P costs are normally recovered as a portion of the sale price. Similarly, sales to the Government on a fixed-price, price-competitive basis will include an appropriate share of the IR&D and B&P costs in the same manner as the contractor's commercial business. It would appear reasonable to recover IR&D and B&P costs on cost-type contracts or fixed-price, negotiated contracts in a similar manner, that is, through equitable overhead allocation.

Profit Recovery

In principle, IR&D and B&P costs could be eliminated as an element of a contractor's overhead. To replace the eliminated cost elements, one could increase the profit level sufficiently to reimburse contractors for their IR&D and B&P work. The philosophy of this approach is sound. Most everyone would agree that, since profits are used at the contractor's discretion, this approach should eliminate several of the controversial issues, such as relevancy, uniformity, etc.

In practice, many obstacles exist in the implementation of this approach. Obviously, a first consideration is "by how much should profits be increased?" The alternatives are either an arbitrary fixed percentage or a determination of a reasonable amount on a contractor by contractor basis. The equity of the arbitrary percentage is debatable as individual figures vary greatly between industries as well as between companies in similar industries. The individual contractor determination is the current method used and it is extremely difficult to administer.

A second point is the demonstrated vulnerability of profits during individual contract negotiations, and/or the difficulty of convincing Congress and the general public that a Government contractor's profits should be increased.

Direct Contract

It has been suggested that Congress could appropriate and control an annual sum of money commensurate with the national total of IR&D costs for Government contractors and that this money could then be allocated among the contractors involved by individual direct contracts.

The problems involved in this approach appear to be awesome. First, it should be realized that the national total of IR&D costs is composed of the costs of literally thousands of individual IR&D projects. Congress would have an impossible task in assessing the merits of the total program. In addition, an equitable basis for allocating such a total sum among contractors is not obvious, and the administrative cost of such an undertaking could be grossly uneconomic.

REASONABLENESS OF COST

Among the major issues involved in IR&D and B&P, the one of reasonableness is the

key issue, far surpassing the others in importance. It is believed that the other issues could be easily resolved if an equitable technique for determining the reasonableness in amount of IR&D and B&P could be agreed upon.

Over the past 13 years, a number of techniques to determine reasonableness either have been tried or extensively studied. Technical evaluation has been used since 1959 even though this technique seems to stress the relevancy and merit of the IR&D rather than the reasonableness of amount. Industry norms for IR&D and B&P by industry group have been studied in depth. Finally, the historical record of each contractor has been considered as the possible basis for future negotiation. This last technique is the one currently specified in DPC 90.

The concept we have recommended is directed toward a reduction in the administrative activities related to IR&D and B&P. Our basic premise is that those cost centers performing a majority of their work in the commercial marketplace or under fixed-price Government contracts already have the motivation for control of indirect costs. For example, under a fixed-price contract, the manager has to trade-off his indirect costs with profit which is a strong control over indirect costs. Further, since accepted accounting practices require the same indirect cost allocation be made to fixed-price contracts as are made to cost-type contracts, any cost center which has a fraction of its work in commercial products or fixed-price contracts will control costs. We believe that the acceptance of this approach will greatly reduce the nonproductive administrative burden of cost control and the negotiation of advance agreements.

DISSENTING POSITION 1

A number of Commissioners* do not support Recommendation 10. They would support the following:

Dissenting Recommendation 10. Recognize in cost allowability principles that IR&D and Bid and Proposal expenditures are in the Nation's best interests to promote competition (both domestically and internationally), to advance technology, and to foster economic growth. Establish a policy recognizing IR&D and B&P efforts as necessary costs of doing business and provide that:

(a) IR&D and B&P should receive uniform treatment, Government-wide, with exceptions treated by the Office of Federal Procurement Policy.

(b) Allowable projects should have a potential relationship to an agency function or operation in the opinion of the agency head. (These will be determined in the negotiation of advance agreements with contractors who received more than $2 million in IR&D and B&P payments during their preceding fiscal year.)

(c) Agency procurement authorization and appropriation requests should be accompanied by an explanation as to criteria established by the agency head for such allowances as well as the amount of allowances for the past year.

(d) A provision should be established whereby the Government would have sufficient access to the contractor's records for its commercial business to enable a determination that IR&D and B&P costs are allowable.

(e) In all other cases, the present DOD procedure of a historical formula for reasonableness should be continued.

(f) Nothing in these provisions shall preclude a direct contract arrangement for specific R&D projects proposed by a contractor.

The treatment of IR&D, B&P, and OTE costs has been a very controversial subject for many years, as described on the preceding pages. The present statutory provisions applicable to payments for such costs by DOD were arrived at after extensive hearings and deliberations. While there are indications that further changes in the treatment of such costs may be warranted, there has not been sufficient evidence of hardship or problems under the current system to justify the drastic change envisioned in Recommendation 10.

The opening paragraph and subparagraph (a) of Recommendation 10 are acceptable. However, the propriety and feasibility of sub-

*Commissioners Chiles, Holifield, Horton, Staats, and Webb.

paragraphs (b) and (c) are questionable.

Subparagraph (b), if adopted, will result in increased costs of between $50 million and $100 million annually. Furthermore, it may encourage contractors to realign their organizations in order to qualify under the 50-percent rule, thus leading to even greater annual DOD costs for IR&D.

Under subparagraph (c), a number of small companies (particularly those engaged in research and development work) may fail to qualify under the 50-percent rule and, thus, would become subject to the test of relevancy. Such contractors are not subject to such test under the present system. This subparagraph would complicate administration of the program and would penalize these small business firms.

Dissenting Position 1 is intended to retain the current DOD procedure covering IR&D and B&P costs, which was adopted pursuant to Section 203 of the fiscal 1971 Military Procurement Authorization Act. Subparagraph (d) was added in the dissenting position to enable the Government to obtain assurance that IR&D and B&P costs are allowable, as explained below.

The Armed Services Procurement Regulation provides that "a contractor's independent research and development effort (IR&D) is that technical effort which is not sponsored by, or required in performance of, a contract or grant . . ." DOD personnel examine Government contracts and grants to assure that efforts included in a contractor's IR&D program are not sponsored by, or required in performance of, such contracts or grants. However, no such examination is made of contractors' commercial contracts or grants on the premise that such contracts or grants are not subject to Government review.

In one particular instance, a contractor has refused to permit access by GAO auditors to his commercial contracts or grants, contending that such contracts or grants are not required to be made available to the Government.

The Government should be entitled to assure itself that all costs labelled as IR&D costs meet the stipulated criterion. In order to avoid misunderstandings and lengthy legal issues, it would be advisable to include in the IR&D advance agreement a provision covering the Government's right of access to commercial records to the extent necessary to enable a proper determination.

Subparagraph (f) was added only to emphasize that the IR&D procedures do not preclude direct contracting in response to contractor-initiated proposals.

DISSENTING POSITION 2*

A member of the Commission** believes that in addition to the prime and dissenting recommendations advanced above, additional mechanisms exist which if adequately explored may offer reasonably acceptable solutions to the IR&D dilemma. As the basic text points out, the dilemma involves the Government's inability to satisfy the opposing goals of (a) stimulating innovation in an unconstrained fashion and (b) obtaining reasonable assurance that tax dollars thus spent result in effort of broad national value as opposed to undue enrichment. The basic text points out that the argument to regard IR&D as "just another allowable business expense" has certain obvious flaws which preclude the adoption of such an approach. The text also points out that a solution to the IR&D dilemma is difficult to find in simply allowing higher profits. Similarly, most knowledgeable observers agree that R&D innovation is not optimally stimulated through direct contract action as controls associated therewith operate to constrain or discourage the very innovation which is sought as the end result.

The current IR&D process then is an attempt to balance the need to stimulate innovation against the need for reasonable control over the funds channeled into such R&D endeavor. The proponents of unconstrained R&D effort point out the need for maximizing stimulation of innovative effort—as the fountainhead of maintaining our Nation's technological lead and international competitive position. The accompanying argument, that funds spent to finance such effort cycle back into the economy in many ways, is valid and deserving of much broader understanding. A continual educational process is essential to such understanding; however, in so doing the basic R&D effort

*While Commissioner Sampson supports the Commission's position as a reasonable solution for the near future, he recommends for potential long-range resolution that the alternative in Dissenting Position 2 be explored.

**Commissioner Sanders.

undertaken must be made more visible. Unfortunately, evaluations as to the worth of such effort are contentious and will likely continue to be so until a larger segment of the populace achieves a more enlightened understanding of the process.

It is doubtful that there are any short-range satisfactory solutions to the IR&D/B&P dilemma. Adoption of either the prime or the first dissenting position advanced herein as a final solution to such dilemma would overlook certain approaches which might offer potential long-range accommodation of the problems inherent in the IR&D/B&P process.

The following devices should be explored on a test case basis by various agencies to determine their suitability as mechanisms to replace the current IR&D and B&P procedure. The following devices should be explored relative to their potential to operate either singly or in various combinations. (The point being that given differences in contractors and agencies—several different, yet concurrent approaches toward IR&D and B&P may be appropriate.)

Various approaches (to be employed singly or in appropriate combination) to stimulate (finance) desirable R&D innovation and effort and to fairly compensate contractors for effort undertaken in the broad national interest on behalf of the Government, in lieu of the current IR&D and B&P process:

- Establishment of a system of national R&D awards whereby appropriated funds are transmitted to various professional societies in the form of grants, the funds to then be subsequently used for annual awards to specific individuals in recognition of work undertaken of particular benefit to the advancement of science and technology.
- Periodic (bi- or tri-annual) announcement by agencies regarding areas in which independent contractor R&D effort is particularly desired, and simultaneous announcement as to the percentage of cost which would be financed by the Government in any particular area of endeavor. This concept is envisioned to operate so that if the Government desired increased effort, for example, in the area of high strength metals, a program could be announced which specified, (a) the total amount of money to be made available over a 2 or 3-year period (or longer) and (b) that a given percentage of cost expended by contractors participating in the program would be financed by the Government. Financing could be in advance, reimbursed after the fact, or some combination of both in the form of progress payments. In either event, such expenditure would be subjected to audit and would necessarily encompass only such effort as is exerted in the specific area specified and not funded under any other direct or overhead reimbursement mechanism.
- Nonprofit cost center approach—this approach envisions contractors who desire to so participate, setting up designated "nonprofit" cost centers whereby the Government would grant a certain amount of money, in advance or after the fact, to contractor *X* (the amount could be based on a certain percentage of the company's business, etc., or it could simply be an arbitrary amount based upon judgments made by the procuring agency). Contractor *X* in turn would credit such funds to a nonprofit cost center and would be free to use the funds to finance any effort or compensate whomever desired in the form of salaries so long as public disclosure is made periodically (through corporate annual reports perhaps) as to the source and application of such funds.
- Various types or combinations of grants, guaranteed loans, and interest or noninterest bearing loans. This approach envisions the use of a range of such instruments over an extended period of time—so that based upon a company's acknowledged expertise in a given area, etc., certain effort may first be underwritten through use of a guaranteed loan, which after a period of time could be converted to a Government loan at prevailing interest rates; after passage of additional time and following an evaluation of the worth of effort undertaken, the Government loan could be converted to an interest-free loan or even a grant in varying amounts. This approach has appeal from the standpoint that private venture capital is utilized to finance the effort at the outset, but Government financing comes into play at appropriate times and in varying degrees

of force, depending upon the evaluated worth of the endeavor in relation to broad national goals. (Similar to the relevance determinations made under the current IR&D and B&P mechanism.)

- Agencywide (and/or cross-agency) blanket contracts—this approach envisions negotiation of a single contract between a company participating in the program and one (lead) agency representing the Government as a whole. The contract should be for a two- or three-year period and it would specify only very broad parameters for the pursuit of certain "nationally relevant" R&D effort. The only stipulation should be that at annual intervals perhaps, and at the end of the contractual period, the contractor would be required to publicly disclose the source and application of such funds (application to the extent of names of personnel whose salaries were in effect subsidized for the period in question as a result of such program.)
- Overhead adjustment—this approach envisions a system somewhat similar to the existing overhead adjustment process but differing in the following significant respects:

  (a) The existing system involves overhead adjustment based upon a prospectively negotiated agreement. This approach would involve an overhead adjustment based upon a retrospective evaluation of the worth of the endeavor under question. Whereas the existing system is based upon forward looking plans, programs, promises, assurances, and an after-the-fact and/or continuing periodic audit, the envisioned approach would simply involve an agreement between the Government and a participating contractor which would provide for after-the-fact (or even progress payment type) reimbursement for effort undertaken, dependent solely upon a Government evaluation of the worth of the endeavor undertaken.

  (b) After-the-fact evaluation, however, should operate to separate out the effort which is really potentially worthwhile, in that the contractor should be willing to undertake such effort on the assumption that its worth can be sustained and Government reimbursement will be forthcoming. On the other hand, under the current system, once an advance agreement is negotiated, all the contractor need do is charge cost which can be audited up to the total of the negotiated advance agreement; and based upon a broad and nebulous relevancy test, generally qualify for a follow-on negotiated agreement for subsequent periods of time.
- Industry norm approach—data in the basic text outlines R&D investment as a percent of annual sales by selected industries and establishes the position that defense IR&D is a vastly smaller percentage of industrywide sales than are those percentages for other industries. If the data are reasonably accurate, and assuming development and the continued existence of relatively undisputed data, an argument can be made for using such data as the basis for pursuing either one or both of the following approaches toward stimulating R&D at appropriate levels through Government financing:

  (a) Tax credit devices—similar to present IRS oil depletion allowance and investment tax credit mechanisms. (Envisioned here is simply doing away entirely with IR&D and B&P as it is now managed and shifting to a tax credit device for offsetting one year's allowed expenditure against a subsequent year's reportable income.)

  (b) Shift to return on investment as an overall profit policy and incorporate therein an analysis of company-financed IR&D effort to determine overall profit on negotiated Government business. (This approach envisions a total abandonment of the current IR&D and B&P mechanism and substitution of a return on investment philosophy for negotiation of profit.) This is perhaps the most straightforward and easily administered approach to the IR&D and B&P dilemma. The feasibility of such an approach could be determined through its test case use by DOD (and other agencies as well) in connection with the return on investment program currently undergoing study within the DOD.

The above approaches should be expeditiously explored in order to reach some timely accommodation between the proponents for the various uses of the scarce funding available to support R&D effort.

CHAPTER 5

Procurement Procedures

Competitive Solicitation

Significant portions of the Federal R&D budget are placed sole-source, sometimes through the use of unsolicited proposals, causing public and private concern over whether adequate competition exists among performers of R&D. The marketplace for Federal R&D procurement differs from a purely competitive one in at least three important respects:

(1) The size of its purchases usually makes the Government a significant, frequently the dominant, and in many fields the sole buyer of R&D.

(2) Identity of product is intrinsically impossible in R&D because of the importance of such qualities as innovation, related experience, and individual qualifications.

(3) Freedom to enter or leave the marketplace is sharply constrained by security classifications, protection of proprietary information, and lack of usefulness of R&D capabilities in other kinds of enterprises.

"Seller rivalry" takes several forms in R&D procurement. The request for proposal (RFP) process for obtaining R&D is one form of rivalry, where a few characteristics of the product may be generally specified. Unsolicited proposals are another form of seller rivalry, differing mainly from RFPs in that no attempt whatever is made to achieve similarity or identity of product. Because awards are few in comparison to the number of unsolicited proposals, the rivalry is intense. Even the apportionment of Federal R&D funds between in-house and outside performers represents an intense form of rivalry for the funds,[1] with the additional condition that the distinction between buyer and seller is partly absent.

Lack of identity of product is probably the single characteristic of R&D which people least comprehend. Basic research is an activity where the product completely lacks identity, since the result depends highly on the skill, insight, and experience of the man or team doing the work and, in addition, is greatly influenced by the findings in the course of the work. Applied research begins to have some similarity of product, but this too is subject to wide variations. Only a few sources are likely to be highly and specifically qualified, though many may have general qualifications. Development exhibits much more similarity of product and usually, but not always, involves a wider field of qualified sources.

Thus, the type of competition for research and exploratory development is far different from the competition obtainable in purchasing more familiar products. The difference results primarily from the emphasis on innovation and creativity by the R&D performer. Diversity is the keynote, and offerors must emphasize unique and sometimes startling approaches rather than the tried and familiar as with many other procurements. This very emphasis on uniqueness of proposal, particularly at the research end of the spectrum, tends to preclude the full use of competitive techniques for R&D procurement.

Standard procurement techniques involve establishing a sufficiently broad baseline of comparable features in proposals to evaluate objectively the full worth of each offer. This in turn generates offers of products and services with essentially common characteristics which, to a considerable extent, can be meas-

[1] See Chapter 2 of this part and Part A, Chapter 6.

ured and compared by an objective common denominator: price. These offers are the antithesis of those expected in procurements demanding innovation. The full use of the familiar competitive processes and techniques are therefore most often inappropriate for R&D procurement.

For these reasons, we conclude that, to the extent the Government attempts to secure innovative approaches to problems through the procurement of R&D, the procedures for such procurement should facilitate the Government's obtaining inventive proposals from rival sources. Likewise, Government R&D procurement must recognize that the uniqueness of such proposals may foreclose the use of fully competitive techniques to decide who has submitted the offer most advantageous to the Government.

The apparent cost items associated with the competitive solicitation of R&D are proposal preparation and proposal evaluation. All or part of such costs are borne by the Government: in the form of overhead costs for proposal preparation by performers, and as direct in-house costs for evaluation processes. The essential fact is that these steps are performed in duplicate for each contender under the principle that the savings resulting from competitive pressures more than offset the bidding costs.

This principle operates generally with respect to solicited R&D. When more than a few proposals are received there is comparatively little added benefit and much additional effort and expense on the part of both the many bidders and on the part of the Government evaluators. Where such additional bidders bring new approaches to the evaluation, they are useful; where they simply add another applicant to an already long list of qualified contenders, the benefit to the Government is only slight, if any.

The diffuse and exploratory character of most R&D makes the preparation of bidders' lists by agencies, and the making of bid-no bid decisions by contractors, a very difficult and hazy matter. If a criticism is to be leveled at this phase of R&D procurement, it can best be described as an ambivalence on the part of the Government between excessive reliance on sole-source procedures, and excessively open competition.

Some agencies apparently do not exercise discretionary authority properly in these areas. In a large sample of competitive R&D contract awards, we found instances of more than 100 contenders for a single solicitation, with an overall average of ten proposals per award.[2] Since, in many instances, the Government ultimately pays bidding costs through overhead, and evaluation costs as part of in-house effort, the total costs of each such selection may come to exceed the value of the resulting contract. It is clearly in the public interest to develop screening methods to reduce an excessive number of major contestants.

An action program of two main thrusts suggests itself. Where competitors are extremely numerous and the Government is a dominant buyer, methods should be found for discouraging weaker contenders. Such a policy will yield long-term savings to the Government and actually intensify the competition. As the second thrust, sole-source awards should be replaced where possible with controlled competitive fields of a few competitors each. The intent would not be to eliminate sole-source awards for unsolicited proposals but to curtail the practice of other types of sole-source awards.

In summary, where possible, competitive announcement for proposals certainly should identify not less than three nor probably more than five "best qualified potential sources," where "best qualified" refers to the particular program being purchased and not to the broad area in which the sources qualify generally. For example, if an R&D program were being planned to investigate advanced wing configurations for Mach 2.5 flight regimes, the qualified bidder list might typically contain 20 or more companies. The "best qualified sources" list would then identify three to five of those who, by virtue of their skills, facilities, and related experience in Mach 2.5 aerodynamics rather than the entire field of aerodynamics, appear to be most suitable. Other applicants could also enter the bidding, provided they feel the effort worth the expense in light of the identified "best qualified sources."

[2] Study Group 11 (Research and Development), *Final Report*, Feb. 1972, p. 165.

Lack of accepted screening methods and concern for Congressional criticism appear to be at the root of the agencies' present reluctance to control excessive competition. We believe that every proposal, fairly submitted, must be carefully considered. We also believe that in-house competence must somehow be used more aggressively to identify a limited mix of contenders to create the necessary competitive pressures and give the Government an adequate range of alternatives, while at the same time giving a clear signal to others who, for one reason or another, are unlikely contenders. The Government should use its R&D buying power to maximize the quality of competition rather than maximizing the number of competitors. A similar treatment of competition in the professional service area may be found in Part A, Chapter 9.

Part A, Chapter 3, contains a full treatment of competition and source selection as related to all procurement. The implementation of the recommendation therein developed would significantly improve the R&D procurement process. The role and importance of competition in major system acquisitions is treated in detail in Part C.

Instruments

Once the performer is selected, the next step in the R&D acquisition process is to reach agreement on the terms and conditions under which the work will be performed. The choice of instrument for funding nongovernmental R&D performers is influenced by many considerations. Among these are the variations of risk and uncertainty presented by R&D objectives; differing requirements for different types of performers, that is, FFRDCs, universities, nonprofit research institutes, and industry; and variables across the R&D spectrum, that is, basic and applied research and development. Questions of procurement versus support of R&D are also involved.

Many of the procedural questions and requirements for R&D procurement are discussed in Part A. Part F considers broad implications of procurement-assistance relationships in selecting between contract and grant instruments.

TYPES OF CONTRACTS FOR R&D

The primary variable determining the selection of the type of contract for R&D procurement is the degree of uncertainty in the Government's ability to describe exactly what it wants. When an agency's needs can be fully specified, procurement can be made by advertised methods, and the contract can be firm fixed price. On the other hand, where its needs and the method of satisfying them can be described in only general terms, procurement is sometimes best accomplished by negotiation, and the contractual relationship should be as flexible as possible. R&D procurement falls typically within this latter category.

Types of contracts to be used by the Government in obtaining R&D have been widely discussed. In 1959, DOD was criticized for excessive use of cost-plus-a-fixed-fee contracts, and it was suggested that firm-fixed-price contracts be used to a greater extent.[3] This lasted well into the 1960's, and DOD, as well as other agencies, stressed the use of fixed-price contracts, sometimes to the exclusion of more appropriate contract types.

At the basic research end of the R&D spectrum, there is less sensitivity to the contract type since goals are generalized and technical risks of meeting objectives are low. The converse is the case for advanced development, or where deliverable hardware is concerned. To oversimplify the situation, the type of contract can make a positive, negative, or no contribution to the performance of the R&D.

In many cases, the unsuitability of the type of contract selected is evidenced by the records of disputes between the parties. Instances can be found where R&D performers assumed risks by contracts which were inappropriate and had to request relief. In other cases, the contracting officer has defaulted the performer. Examples where the nature of the contract made a positive contribution are more difficult to find. When problems can be identified which are traceable to the form of contract used, the problems are evidence the parties involved did not take into account the very nature of R&D procurement.

For R&D procurement the following two propositions are generally accepted: (1) the

[3] *Ibid.*, p. 147.

fixed-price contract is normally not suitable in view of the basic unpredictability of risk and the outcome of results; (2) a cost-reimbursable contract is preferred where the sponsor expects to have some role in the direction of the work to be performed.

These two propositions oversimplify the situation and do not take into consideration the wide variety of other options open to the parties to enhance the performance of the necessary services. For example, in some instances a fixed-price contract may be totally appropriate for the performance of R&D if the degree of risk is reasonably known by the parties, or if other means are available to describe adequately the relationship between performer and sponsor. Thus, when the performer is obligated only to provide a stipulated level of effort and to use his best efforts to achieve some R&D objective, the use of a fixed-price contract may be appropriate. Conversely, inappropriate use of a cost-reimbursable contract can fail to provide a suitable incentive for the effective performance of work. It also should be pointed out that there is a substantial difference in the administrative expense of cost-type and fixed-price contracts. For cost-type contracts the burden of cost analysis in proposal preparation and the accounting procedures in performance auditing often eliminate many competent sources, particularly small business, from competing for Government R&D. This factor should be a consideration in the selection of contract type.

MASTER AGREEMENTS

Once the sponsor and performer have agreed on a suitable instrument for the R&D funding, specific details must be worked out and agreed to regarding requirements and conditions under which the work will be performed. In most instances this is done individually for each contract or grant which frequently requires a repetition of effort on the part of both agency and performer staffs. This is necessitated by current practices in the award of contracts and grants even though the terms and conditions might be the same for an individual agency. Additionally, separate negotiations are required with separate agencies, due to the differences in policies, regulations, and administrative requirements for the separate agencies. While certain agencies (for example, DOD and NASA) strive for uniformity of practices between their various bureaus and offices, standardization among all agencies has met with only limited success. The current OMB FAR (Federal Assistance Review) program has made a start toward increased uniformity among agencies in certain aspects of contract and grant administration.

Recommendation 11. Encourage the use of master agreements of the grant and contract types, which when executed should be used on a work order basis by all agencies and for all types of performers.

A potential method for reducing the time and effort required to initiate R&D work and for simultaneously producing substantial cost savings is the negotiation of master agreements with performer organizations. Similar practices have been applied by elements of DOD, NASA, and HEW, in the form of "call contracts," "blanket bailment agreements," "basic ordering agreements," and "basic agreements." These agreements enable the agency to negotiate periodically all of the standard clauses for fixed-price, cost-plus-a-fixed-fee, and incentive contracts and many special clauses covering overhead practices and procedures. This practice seems worthy of adoption by each agency that places a number of contracts or grants each year with the same performer.

It appears further that one standard agreement could be negotiated with a particular institution by one agency, conceivably a cognizant agency, in the fashion established by BOB Circular A–88 for administrative aspects of grants and contracts at educational institutions. In many instances this master agreement could be used by all other agencies so that individual R&D work efforts could be negotiated separately and incorporated into the standard agreement by simply adding a work order containing the new statement of work backed by the required fund citation.

Our studies suggest the feasibility of negotiating such master research contract and/or grant agreements with nonprofit educational institutions and perhaps other types of per-

formers. Once negotiated, the master agreement could remain in effect for a fixed period (for example, two years) without any changes except those mandatory by statute. These documents would contain the required standard provisions. Each agency contracting unit could then negotiate task orders with the performer which would include time, money, work scope, and other provisions of special application and would incorporate the appropriate standard grant or contract agreement into the task order by reference. Acceptance of the master documents by performers does not have to be mandatory, but successful use of such an instrument with other similar organizations should make it generally acceptable. Master documents and task orders should greatly increase uniformity and sharply reduce paperwork in R&D procurement.

The separate agencies would agree on a standard form of master agreement only if there were uniformity in the R&D procurement regulations, as suggested earlier. We belive that such agreements are one of the benefits which could result from uniform R&D procurement regulations. We therefore favor the use of such agreements, one type for grants and another for contracts, insofar as possible for all types of performers. Such practice should lead to greater simplification and economy in the award and administration of R&D contracts and grants.

HARDWARE EXCLUSION CLAUSE

R&D programs often lead to complex and expensive hardware production or service delivery programs. Not infrequently the Government needs contractor expertise in formulating its plans yet such action often suggests a conflict of interest.

Recommendation 12. When a potential organizational conflict of interest exists and use of a hardware exclusion clause is proposed, require a senior official of the procurement agency to examine the circumstances for benefits and detriments to both the Government and potential contractors, and reach and justify his decision to contract with either no restraint, partial restraint, or strict hardware exclusion provisions.

The Government looks to industry, nonprofit, university, and FFRDC performers for aid in defining a variety of needs, ranging from conceptual studies of agency program requirements to prototype production and testing for specific systems. Contractors with production or service capabilities, who provide assistance to the Government during the R&D period, often are the most qualified to undertake the more profitable production which follows R&D. At the same time, contractors employed in the planning phase inevitably gain a unique insight into the proposed program and, in extreme cases, could possibly write specifications which only their facilities could satisfy. Such contractors have an unfair advantage in the later bidding for the resulting contracts. Hardware exclusion clauses are used by elements of Government (for example, DOD, NASA, and AEC) to preclude contractors involved in the early definitional phases of Government programs from receiving other contracts to produce or deliver the hardware or services resulting from their study and definition efforts.[4]

The Bell Committee Report in 1962 [5] recognized the concerns and problems arising from the Government's heavy reliance on nongovernment sources to assist in the determination of policies and the performance of management functions which Government itself should perform. That report accepted as desirable the high degree of interdependence and collaboration between Government and private institutions, including R&D performance in the latter, and suggests that this mutual effort is in the best national interest because it affords the greatest opportunities for initiative and the surfacing of ideas from all elements of the technical community. The conflict-of-interest situation arises directly from the close mutual interdependence of Government and the private sector. The problem then becomes: How can the Government obtain desired expert assistance from sources which also produce hardware or services and still achieve an equitable competitive climate during the procurements resulting from the advice of these

[4] See ASPR 1-113.2, *Organizational Conflicts of Interest*, Apr. 1971; and DOD Directive 5500.10, June 1, 1963, app. G.

[5] U.S. Bureau of the Budget, *Government Contracting for Research and Development*, submitted by the President to the Senate and reproduced as Doc. 94, 87th Cong., 2d sess., 1962.

sources? While all parties can agree on the purpose of the hardware exclusion clause and its propriety, the circumstances which delineate its use and the mechanics of its employment are the cause of much debate and difference of opinion.

Concern over hardware exclusion varies depending on the outlook of the parties concerned:

- When an agency feels that the most eminently qualified source for assistance in the R&D of highly complex systems or services is a contractor who specializes in that kind of product, it will use him as a source regardless of the conflict of interest issue. Agency procedures, if not basic procurement authorities, permit this in the interest of effectively accomplishing the mission requirement.
- Highly qualified production contractors who also possess strong R&D planning capability are frequently faced with hardware exclusion clauses. Often the profits to be gained from performing the R&D planning efforts are minor compared to those which could be realized from the large programs which follow. Such firms must choose between competing for the R&D/planning contract or waiting to compete for the follow-on hardware or service programs. Continual nonparticipation in R&D/planning efforts, however, results in loss of leadership and competitive position in the product line. Such firms favor a policy which will allow them to participate fully in both the R&D/planning and the production phases of a program.
- Qualified production contractors without strong R&D capability see their potential for winning production contracts jeopardized when R&D/planning contracts go to firms with whom they must compete for follow-on production. These firms generally favor strong policies to exclude production contractors from requirement definition.
- Other firms see business going to Government-created or Government-sponsored nonprofit organizations, which do work that should or could be performed by private industry which is deterred from competing due to hardware exclusion provisions.

The Council of Defense and Space Industry Associations (CODSIA) believes that industry should be allowed to participate in the management planning and R&D functions to the maximum extent possible, and that the hardware exclusion principle should be applied only in those cases where specifically defined areas of conflict exist. CODSIA feels that the Government's role should not be to restrict competition and natural advantages that one contractor may have over another, but should be concerned rather with preventing situations which create bias and unfair competitive advantage in favor of one production source. This position is quite compatible with the positions expressed by DOD and NASA.

Firms with little or no production capability but which are strong in planning, systems analysis, and basic research, recognize an advantage to them in the form of less competition from large production firms if strong hardware exclusion clauses are included in RFPs. This is reflected in the greater numbers of responses received from such firms when the procuring agency notifies prospective bidders that a hardware exclusion clause will be included in the resulting contract.

The Government position, as expressed in the FPR and ASPR, is to be fair and impartial to all segments of the private performer community, notwithstanding public policy to support nonprofit educational institutions and to assure opportunities to small business for obtaining a fair share of Government contract awards. Equally important, as recognized by the Bell Report, FPR, and ASPR, is the need to procure effectively and efficiently from qualified sources. The Government realizes that the hardware exclusion clause applies almost exclusively to some form of R&D. Government policy permits waiving organizational conflict of interest provisions in circumstances which would deny the required expertise to the Government. This suggests that the Government's obligation to satisfy its needs, particularly in critically important areas, is paramount to its responsibility to avoid placing a contractor in a favored position to obtain production contracts.

We recognize that the Government's responsibility in this dilemma of organizational conflicts is split between its duty to avoid giving

an unfair advantage to one contractor and its duty to use the best qualified sources for its R&D requirements. Such an unfair advantage could be eliminated by excluding contractors from acting in a capacity where they could influence or designate requirements which they in turn might produce. This would deny to such contractors an opportunity to compete for and provide the advisory and definitional services required. It would conversely be advantageous to firms who sell only "think-type" services. Also, in many instances it would deny to the Government the services of sources who have, through independent research and product improvement programs, gained exceptional capability and qualifications to do the work.

These considerations suggest that strong Government leadership and ability are essential to evaluate the circumstances of each case and thus permit the Government to act wisely concerning organizational conflicts of interest. There will be times when agencies can impose the hardware exclusion clause with little effect on agency goals or broader national interests. At other times, economic, security, or other reasons such as national interest will require use of the best source for "advisory and requirement influencing contracts," and that source could well be the most qualified source from which to procure resulting requirements. At the same time, it is important to consider steps to develop in-house planning capabilities to the maximum possible degree to avoid to some extent the need for outside systems planners, managers, and evaluators.

CHAPTER 6

Summary

The Commission has made an in-depth study of how the Government procures research and development. We are proposing recommendations which we believe will not only improve the procurement process but also will assist in meeting national objectives. The results of our analysis break down into two major areas. The first is related to using the procurement of R&D to maximize innovation. The second highlights a very recent change taking place in the roles of and relationships between the public and private sectors.

When the Government procures R&D it is buying innovation, ideas, and a road to the future. The procurement process should be a tool to enhance the product and the resulting benefits; we believe that our recommendations will help meet this objective. For example, any procedural changes that reduce the current unproductive administrative burden on the performers is certainly a move in the proper direction.

Further, we believe that the procurement of R&D is sufficiently different from other types of procurement that special treatment of the process should be considered. This includes statutory changes to recognize negotiation as the normal procurement technique for R&D, the development of uniform regulations for R&D, changes in source-selection procedures to maximize competition rather than the number of competitors, better attitudes about accepting unsolicited proposals, and the selection of the preferred types of contractual instruments for R&D.

We found major changes being made in the roles of the public and private sector R&D performers and the relationships between them. President Nixon's Science and Technology Message of March 16, 1972, highlighted these changes. We strongly endorse the most efficient use of all available resources, public or private, to meet national objectives. We have made recommendations regarding the roles of Federal in-house R&D laboratories, the use of Federal funded research and development centers (FFRDCs), the use of consortia of R&D performers, and an organized and expanded program to promote interagency cooperation to meet national goals broader than the mission of any single agency. We have included background material on the relationship of R&D and productivity and data showing that our technology is not being applied to full advantage to counter the economic progress being made by our foreign competitors in high-technology markets. A new type of partnership between the Government and all types of R&D performers is proposed, using new techniques in the R&D procurement process as a basic mechanism.

A major consideration repeatedly stressed throughout our treatment of R&D has been the importance of the technology base. Many applications of the base have been highlighted. A particular need for a strong technology base is to serve as a reservoir of capability to initiate new major systems. Part C, Acquisition of Major Systems, has as a paramount theme the importance of innovation in developing new systems concepts and the permanent need of a healthy technological base.

APPENDIX A

History

United States Government involvement with R&D may be said to have its origin in the Constitution, in which Article I, section 8, decrees that "The Congress shall have Power . . . to promote the Progress of Science and . . . Useful Arts." The Constitution also established congressional powers to "fix the Standard of Weights and Measures," a function currently of the National Bureau of Standards, and provided other powers of Government which have incorporated important R&D efforts as parts of their missions.

Scientific efforts in the earliest days of the Republic emphasized natural sciences. The Government participated also in technological innovation, including a grant of funds in 1830 to the Franklin Institute to study causes of boiler explosions and support of development of the first experimental telegraph line by S. F. B. Morse. It also funded advances in military technology used during the Civil War and World War I as well as civilian-oriented technologies developed in the early 20th century.

The 19th century saw the development of such institutions as the Smithsonian Institution and the National Academy of Sciences as well as the establishment of land grant colleges to stimulate and foster development of agricultural sciences so important to the country's developing economy. Needs of technology were served further with creation of the National Bureau of Standards in 1901, formation of the Department of Commerce in 1903, and establishment in 1915 of what was to become the National Advisory Committee for Aeronautics, the forerunner of the National Aeronautics and Space Administration.

The increasing interaction of R&D activities of Government and nongovernment organizations continued to the beginning of World War II. The war itself had a most significant impact on Government R&D activities and attitudes. Increasing awareness of and concern for the national defense posture led to the formalization of many Government R&D organizations, with the Manhattan Engineering District representing a new peak in organization of national R&D effort toward a high priority goal, development of the first nuclear bombs. By the end of World War II, there was a greatly increased public and scientific community appreciation of the importance of R&D toward meeting national goals. This new awareness led to the formation of R&D programs of such Federal agencies as the National Institutes of Health in 1944, the Atomic Energy Commission in 1946, the Office of Naval Research in 1947, and the National Science Foundation in 1950. The R&D programs in these new agencies as well as in older departments grew steadily in the 1950's, increasing the national commitments to basic and applied research and the development of scientific capabilities in the Nation.

New impetus to scientific development came in the late 1950's in response to Soviet Union successes in space exploration and ballistic missile technology. The United States assigned new priorities to R&D, as evidenced by President Kennedy's commitment to the man-on-the-moon program of the 1960's. The funding of Government R&D interests increased by about 15 percent per year,[1] with increased emphasis on science education and training and renewed attention to basic research and the use of grants to fund research.

Government organization for science and

[1] Calculated by the Commission from data in NSF Report 71-35, vol. XX, p. 3.

technology also received new stimulus. In 1957, President Eisenhower created the post of Special Assistant to the President for Science and Technology, and reorganized and transferred to the White House the President's Science Advisory Committee. The Federal Council for Science and Technology was established in 1959 to deal with interagency science and technology affairs, and President Kennedy in 1962 established the Office of Science and Technology. At the same time, the Congress became more involved in the R&D process, with establishment of Senate and House committees, subcommittees, and studies relating to science, technology, and specific R&D programs.

Although the decade 1957–1967 was one of growth and support of R&D programs, particularly in the defense, space, and nuclear agencies, profound changes in attitude developed in the latter half of the 1960's. Although attaining the goal of a manned lunar landing in 1969 brought a considerable sense of accomplishment, public disenchantment led to questions regarding the utility of costly defense and space endeavors especially in the presence of growing discontent and concern for social problems such as education, the environment, health, housing, and transportation. These changes in national attitude dampened the enthusiasm for basic research, academic science, and the training of scientific manpower in favor of increased attention to more immediate and visible goals in the public sector.

APPENDIX B

Summary of Defense Procurement Circular 90 (DPC 90)

Definition

A contractor's independent research and development effort (IR&D) is that technical effort which is not sponsored by, or required in performance of, a contract or grant and which consists of projects falling in three areas: (1) basic and applied research, (2) development, and (3) systems and other concept formulation studies. Bid and proposal (B&P) costs are the costs incurred in preparing, submitting, and supporting bids and proposals (whether or not solicited) on potential Government or non-Government contracts.

Relevancy

A potential relationship to a military function or operation.

Uniformity

DPC 90 applies only to DOD.

Composition and Allocability of Costs

COMPOSITION OF COSTS

IR&D and B&P costs shall include not only all direct costs but also all allocable indirect costs except that general and administrative costs shall not be considered allocable to IR&D and B&P. Both direct and indirect costs shall be determined on the same basis as if the IR&D and B&P project were under contract.

ALLOCATION

As a general rule, IR&D and B&P costs shall be allocated to contracts on the same basis as the general and administrative (G&A) expense grouping of the profit center in which such costs are incurred.

Reasonableness

COMPANIES REQUIRED TO NEGOTIATE ADVANCE AGREEMENTS

Any company which received payments, either as a prime contractor or subcontractor, in excess of $2 million from DOD for IR&D and B&P in a fiscal year is required to negotiate an advance agreement with the Government which establishes a ceiling for allowability of IR&D costs for the following fiscal year. Computation of the amount of IR&D and B&P costs to determine whether the $2 million criterion was reached will include only those recoverable IR&D and B&P costs allocated during the company's previous fiscal year to all DOD prime contracts and subcontracts for which the submission and certification of cost or pricing data was required in accordance with 10 U.S.C. 2306(f). The computation shall include full burdening in the same manner as if the IR&D and B&P projects were contracted for except that G&A will not be applied.

Companies which meet the above threshold shall submit technical and financial information to support their proposed IR&D program in accordance with guidance furnished by the

Armed Services Research Specialists Committee. Results of the technical evaluation performed by the Armed Services Research Specialists Committee, including determination of potential relationship, will be made available to the contractor by the cognizant agency's central office.

Ceilings are the maximum dollar amounts of total costs for IR&D work that will be allowable for allocation to all work of that part of the company's operation covered by an advance agreement. Within the ceiling limitations, contractors will not be required to share IR&D costs. In negotiating a ceiling, in addition to other considerations, particular attention must be paid to such factors as:

- The technical evaluation of the Armed Services Research Specialists Committee including the potential relationship of IR&D projects to a military function or operation
- Comparison with previous year's programs including the level of the Government's participation
- Changes in the company's business activities.

COMPANIES NOT REQUIRED TO NEGOTIATE ADVANCE AGREEMENTS

Allowable IR&D and B&P costs for companies not required to negotiate advance agreements shall be established by a formula, either on a companywide basis or by profit centers, computed as follows:

- Determine the ratio of IR&D and B&P costs to total sales (or other base acceptable to the contracting officer) for each of the preceding three years and average the two highest of these ratios: this average is the IR&D and B&P historical ratio.
- Compute the average annual IR&D and B&P costs (hereafter called average), using the two highest of the preceding three years.
- IR&D and B&P costs for the center for the current year which are not in excess of the product of the center's actual total sales (or other accepted base) for the current year and the IR&D and B&P historical ratio computed above (hereafter called product) shall be considered allowable only to the extent the product does not exceed 120 percent of the average. If the product is less than 80 percent of the average, costs of up to 80 percent of the average shall be allowable.

Treatment of the Elements

IR&D and B&P treated separately but linked as follows:

A separate dollar ceiling for IR&D and B&P. However, provision shall be made permitting the contractor to recover costs for IR&D above the negotiated ceiling, provided that recovery of B&P costs covered by the same agreement is decreased below its ceiling by a like amount (and vice versa).

APPENDIX C

R&D and Productivity

One reason for the crucial importance of the advancement of technology is its relationship to national economic growth and productivity and the consequent generation of revenues to finance the Nation's many social and environmental programs. Since R&D is not the only factor contributing to economic growth and productivity and since its contribution is not independent, but complementary with investment and education, it is very difficult to quantify the relationship. Nevertheless, a number of attempts have been made to measure the contribution of R&D to economic growth and productivity.

First are case studies of particular innovations and their rates of return. There are not enough of these case studies to aggregate into a national estimate. They tend to focus on success stories, such as Griliches' study of hybrid corn, which concluded that the rate of return was at least 700 percent per year as of 1955.[1]

Estimates for Firms and Industries

Studies for groups of firms and for whole industries give a better picture of the payoff from R&D, since they include all research expenditures, whether successful or not.

Terleckyj examined all manufacturing in 20 industries. He found that a one percent increase in the growth rate of cumulated R&D expenditures was associated with a 0.7 percent increase in the rate of productivity increase. The rate of growth of industry productivity increased by 0.5 percent for each tenfold increase in the ratio of R&D expenditures to sales.[2] Industries with a high ratio of research expenditures to sales had not only higner rates of productivity gain, but higher rates of growth and a higher proportion of their sales (1960) from new or substantially changed products not in existence four years earlier.[3]

Minasian,[4] in a study of 17 chemical firms for the period 1948–1957, found a gross return of 54 percent on investment in R&D. Mansfield [5] found marginal rates of return averaging 40 to 60 percent for ten petroleum firms, and between 7 and 30 percent, depending on the assumptions used, for ten chemical firms. He also studied food, apparel, and furniture and found that for each one percent increase in the rate of growth of cumulated R&D expenditures, there was a 0.1 to 0.7 percent growth in productivity, depending on the assumptions (the weight of opinion being that the assumption underlying the larger figures is closer to reality).

Raines,[6] in a study of 24 manufacturing industries, estimated that on the average R&D conducted by an industry raised productivity 1.3 percent annually, and R&D conducted by industries supplying it with inputs raised its average annual productivity increase another 1.1 percent. These two sources accounted for more than half the average productivity gain

[1] Griliches, "Research Costs and Social Returns: Hybrid Corn and Related Innovation," *Journal of Political Economy*, vol. 66, Oct. 1958.

[2] Terleckyj, *Sources of Productivity Advance* (unpublished Ph.D. dissertation, Columbia University), 1960.

[3] Terleckyj, *Research and Development: Its Growth and Composition*, National Industrial Board Studies in Business Economics, No. 82, New York, 1962, pp. 55–56.

[4] Minasian, *The Economics of Research and Development in the Rate and Direction of Inventive Activity: Economic and Social Factors*, National Bureau of Economic Research, Princeton, Princeton University Press, 1962.

[5] Mansfield, *Industrial Research and Technological Innovation*, New York, W. W. Norton & Co., 1968, pp. 200ff.

[6] Raines, *The Impact of Applied Research and Development on Productivity*, Working Paper No. 6814, St. Louis, Washington University, Department of Economics, Sept. 1968.

of 4.5 percent a year in the 24 industries examined. All of these studies understate the contribution of R&D to productivity increase and economic growth because much of the contribution accrues to industries other than those performing R&D. Raines attempts to account for this interindustry effect in part, but his group of industries is too limited to account for it in full.

Various other writers have found positive and significant correlations between R&D intensity (ratio of R&D expenditures to sales or value added, ratio of R&D personnel to total employment), profits, growth of sales, and rate of productivity growth.[7] This is true both in industries whose research is mainly company-financed, such as chemicals, and in industries whose research is mainly financed by the Government. Further, the correlations apply both to firms within an industry and between industries and suggest that the net cost of R&D procurement to the Government is less than its budget cost, since the performance of R&D results in higher taxable income.

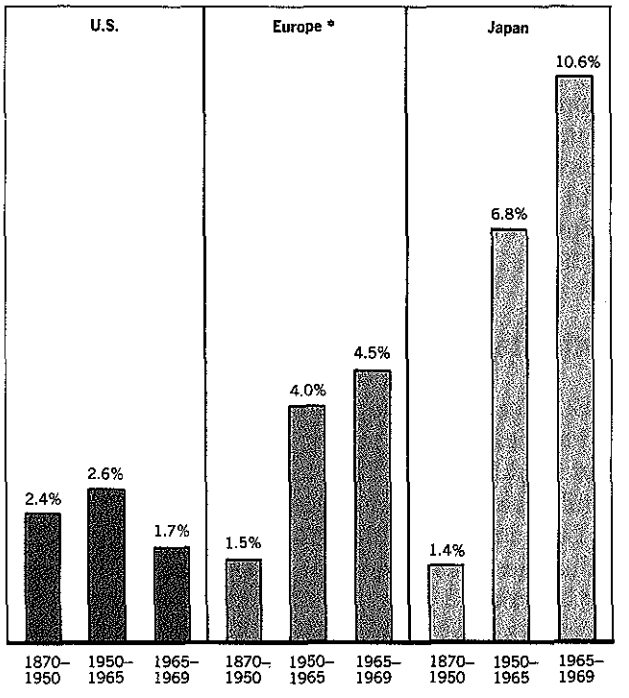
The Russian economist Komzin estimated the relation between an increase in R&D expenditures and increase in output for the United States. He found that expenditures on R&D were several times more effective in increasing output than the same amount spent on fixed capital. For the period 1951–1966, an incremental dollar spent on R&D was associated with an increase of $2.39 in output, assuming a five-year lag between R&D expenditures and associated increases in output, and $4.36 assuming a ten-year lag. Conversely, the increase in output associated with investment in fixed capital was only $0.346.[8]

Estimates of the contribution of R&D to productivity at the national level are more complete than estimates limited to payoffs for a firm, industry, or group of industries. Further, they incorporate interindustry effects which are largely excluded in the estimates with more limited scope.

Former Secretary of Commerce Maurice Stans points out that, historically, U.S. productivity and productivity growth far outpaced other countries mainly because of large-scale imports of capital and foreign technology, immigration of skilled adult manpower, growth in markets, high wages which motivated invention of laborsaving devices, innovative spirit, lack of rigid traditions, and comparatively low war losses. From 1870 to 1950, the U.S. rate of productivity growth exceeded Europe by 60 percent and Japan by 70 percent. Starting in 1950, the situation was reversed, and U.S. productivity growth now lags well behind Europe and Japan as is evident in figure 1.

From 1950 to 1965 our productivity growth rate trailed Europe by 35 percent and Japan by 60 percent. The trend since 1965 shows an even more rapid relative decline: U.S. rates

COMPARATIVE PRODUCTIVITY
(AVERAGE ANNUAL GROWTH RATE)



* Italy, Germany, France, Belgium, Netherlands, and U.K.

Source: Statement by Maurice Stans before the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, 92d Cong., 1st sess., July 1971, chart 6.

Figure 1

[7] Scherer, "Corporate Inventive Output, Profits and Growth," *Journal of Political Economy;* Brown and Conrad, *The Influence of Research and Education on CES Production Function,* in Brown, ed., *The Theory and Empirical Analysis of Production,* National Bureau of Economic Research, Columbia University Press, 1967.

[8] Komzin, "The Economic Impact of Scientific and Technological Progress," in UNESCO, *The Role of Science and Technology in Economic Development,* Science Policy Studies and Documents no. 18, UNESCO; Paris, 1970, pp. 115–117.

trailed Europe by 60 percent and Japan by 84 percent. These differentials in rates result from unprecedented levels of productivity growth in Europe and especially in Japan, and from declines in U.S. productivity growth (1965–1969) which was only 1.7 percent compared with 4.5 percent in Europe and 10.6 percent in Japan.[9]

It is worthwhile to quote from the report of the President's Task Force on Science Policy:

> Economic growth will, over a long period of time, define the total level of resources within which our national goals must be achieved. Because of the central significance of economic growth to all other national goals, it is especially important to point out its dependence on science and technology.
>
> If a major national goal is increasing the quality of life for the mass of our population, it becomes essential that continued technological development also be a high priority national goal. A stagnant technology will mean a stagnant economy. In this regard, it is of interest to note the statement of Mr. Kosygin to the XXIII Party Congress in March 1966, "The course of the economic competition between the two world systems depends on the rate of development of our science and on the scale on which we use the results of the research in production." [10]

To summarize, it appears reasonable to state that technology growth has a significant effect on continued economic growth and on continuing increases in the productivity of individual companies, whole industries, and the overall national economy. Further, a number of leading economists believe that, in a highly industrial country such as the United States, technology growth is the key catalyst to economic growth while education and capital formation play supporting roles.

[9] Stans, Statement before the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, 92d Cong., 1st sess., July 1971, pp. 8–9.

[10] *Science and Technology, Tools for Progress*, the report of the President's Task Force on Science Policy, Washington, Apr. 1970, pp. 11–12.

APPENDIX D

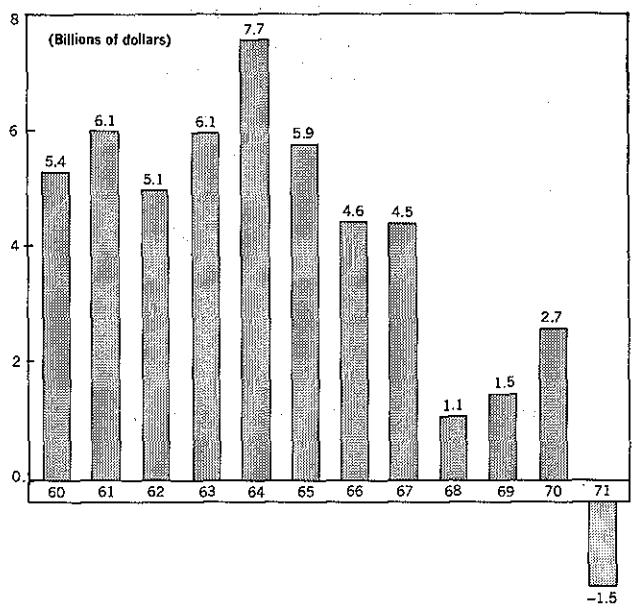
Technology and Foreign Competition

The United States has not always enjoyed a favorable manufacturing balance of trade. Prior to 1900, this country was primarily an exporter of raw materials and an importer of manufactured products. During that period the country's manufacturing trade ratio ran substantially below one. But in the second half of the 19th century, the concept of assembly-line production of interchangeable parts (originated in the United States by Whitney and Colt) took hold and provided a solution to the shortage of craftsmen in the New World. This concept was rapidly accepted in this country but not in Europe which, on the whole, clung to the craft production of quality products. The resulting ability of the United States to produce in quantity with a relatively small unskilled labor force led to an unprecedented reduction in unit labor costs and the introduction of new, low-priced products opened up vast new markets, both at home and abroad. The result was a complete reversal in the manufacturing trade ratio by the end of the 19th century.

This favorable balance of trade (particularly in manufactured products) and rapidly growing U.S. productivity continued almost unabated through the first half of the 20th century. However, since World War II, there has been a steady deterioration in certain areas of our balance of trade. The overall U.S. balance of trade in recent years has deteriorated from surpluses of $5–$7 billion in the early 1960's to levels of $1–$2 billion since 1967. In 1971, the trade surplus disappeared completely and was replaced by a deficit of $1.5 billion. This was the first trade deficit since 1893 [1] (see fig. 1).

[1] Stans, Secretary of Commerce, Statement to Subcommitee on Science, Research, and Development, House Committee on Science and Astronautics, July 27, 1971, p. 6.

U.S. TRADE SURPLUSES



Source: Statement by Maurice Stans before the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, 92d Cong., 1st sess., July 1971, chart 1.
Statement of Peter Peterson before the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, Second Series of Hearings on Science, Technology, and the Economy, 92d Cong., 2d sess., Apr. 11, 1972, p. 3.

Figure 1

To understand more fully the parameters of this trade problem, the overall balance of trade can be broken into various categories:

- Agricultural products
- Raw material (minerals, oil, etc.)
- Low-technology manufactures (textiles, iron and steel, footwear)
- High-technology manufactures (computers, automotive products, aircraft and other

transportation equipment, chemicals, machinery, scientific and professional instruments).

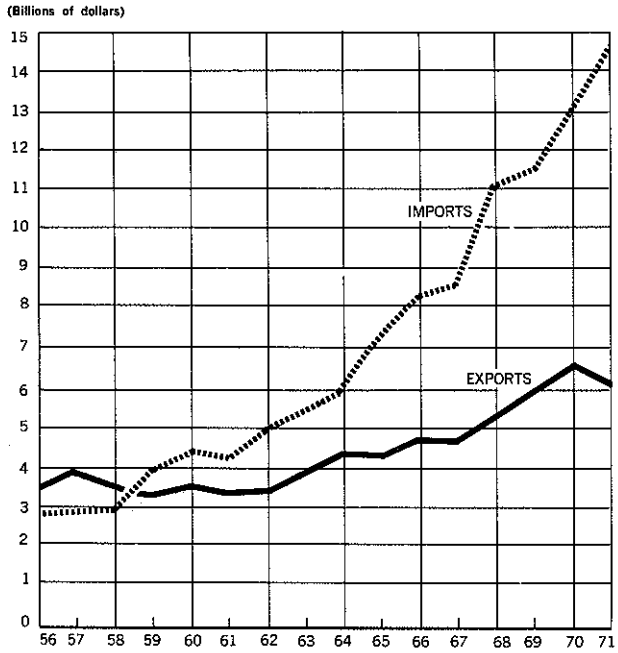
Categorizing the U.S. trade into such groups facilitates an analysis of the problems and more closely identifies the relationship between technology growth and U.S. trade balances. Figures 2, 3, and 4 plot imports and exports in each of the categories. These figures show the trends in the differential between imports and exports and clearly illustrate that high-technology exports have not only maintained a decisive edge over high-technology imports but also have provided the margin to offset the deficit in two of the three other categories.

The following additional points can be made: [2]

- Agricultural products show a small but fluctuating surplus.

[2] Stans statement, note 1, *supra*, pp. 6–7. See also Peterson, Secretary of Commerce, Statement to Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, Apr. 11, 1972, Chart 1.

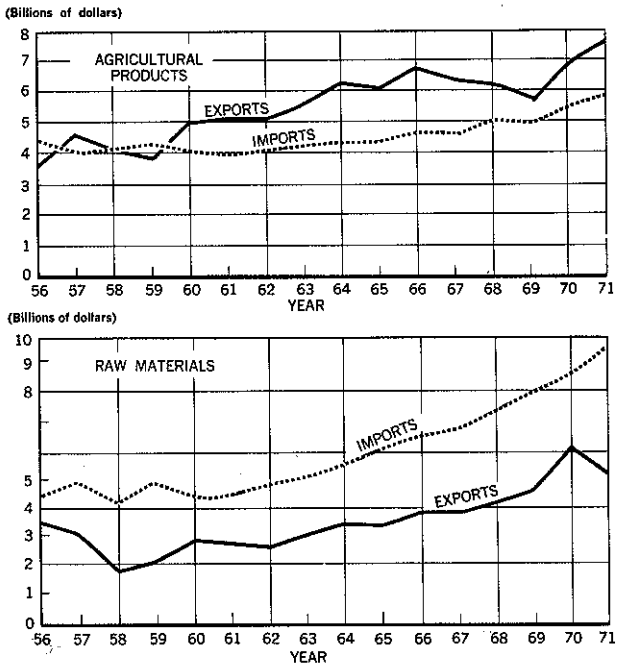
TRADE IN LOW-TECHNOLOGY MANUFACTURES



Source: Same as figure 1; Stans statement, chart 3; Peterson statement, chart 1.

Figure 3

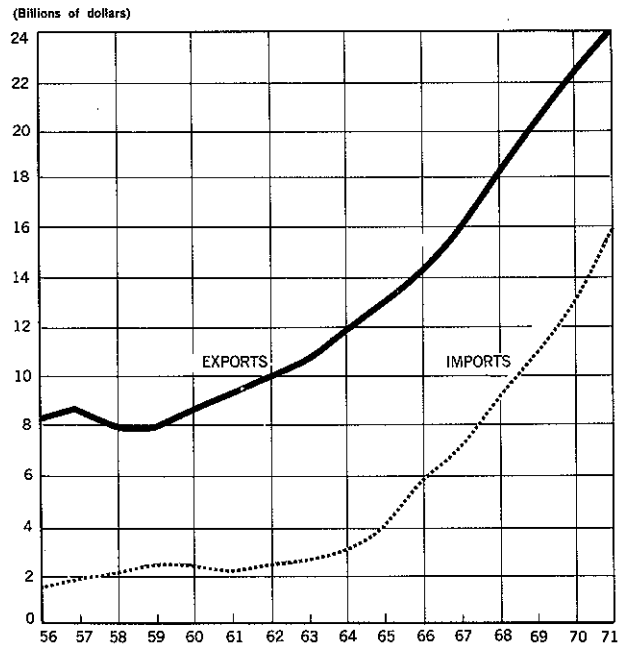
TRADE IN AGRICULTURAL PRODUCTS AND RAW MATERIALS



Source: Same as figure 1; Stans statement, chart 2; Peterson statement, chart 1.

Figure 2

TRADE IN HIGH-TECHNOLOGY MANUFACTURES



Source: Same as figure 1; Stans statement, chart 4; Peterson statement, chart 1.

Figure 4

- Raw materials have a large and persistent deficit running from $2.5 billion in 1970 and increasing to $4.1 billion in 1971.
- The major trade losses have occurred in low-technology products. From 1951–1955 the United States showed an average annual surplus of $1.8 billion in these products. Deficits started in 1958 and by 1965 a deficit of $2.9 billion was realized; by 1970 this deficit more than doubled to $6.2 billion while in 1971 it increased to $8.3 billion. It is likely to continue to increase.
- The increasing deficit in low-technology products, plus the chronic deficit in raw materials, has been offset in the past by sizeable but stable surpluses in high-technology products. However, a surplus of $9.6 billion in 1970 was replaced by a substantial reduction to $8.3 billion in 1971.

The foregoing data adequately supports the hypothesis that technology-intensive products have, over the last decade, created a favorable balance of trade and, until 1971, were able to offset unfavorable balances in other commodity groups. Given the validity of this hypothesis, why then, with the massive U.S. commitment to R&D in comparison to other countries, is the U.S. balance in high-technology products deteriorating? Table 1 indicates the U.S. expenditures for R&D in comparison to the two leading competitors, Japan and West Germany. The U.S. expenditures and value exceed by more than twice those of either Japan or West Germany. The data also show both a greater rate of growth and a greater use of foreign (U.S.) technology by both foreign countries.

TABLE 1. ESTIMATED CIVILIAN R&D EXPENDITURES (Millions of dollars)

	1959	*1968*	*Growth*
United States	5,543	13,093	136%
West Germany	1,050	3,952	276%
Japan	680	2,939	332%
	*1959**	*1968**	*Growth*
United States	5,759	13,903	141%
West Germany	1,608	5,336	232%
Japan	1,051	4,822	359%

*Adding capitalized value of purchased foreign technology.
Source: Stans statement, chart 7. Growth data calculated by Commission.

Another factor is illustrated by Table 2. It is obvious from this table that the U.S. cost of labor exceeds that of all other countries by a substantial margin. Therefore, our foreign competitors need only match or even approach our technology to be able, with their much lower labor costs, to offer very potent competition, even in our domestic markets. In other words, the U.S. must maintain a substantially superior technological position and therefore a productivity factor in order to compete.

TABLE 2. INDEXES OF COMPARATIVE LABOR COST IN MANUFACTURING*

	1960	*1965*	*1970*
United States	100	100	100
Japan	11	16	26
United Kingdom	32	36	37
France	30	37	39
West Germany	32	45	54
Canada	82	72	83

*Including fringe benefits.

Source: Stans statement, chart 10.

The situation regarding the use of technology, particularly the use of "borrowed" technology, was well put by Dr. Frederick Scherer, economist at the University of Michigan and co-author of *The Weapons Acquisition Process*, in an interview with the Commission staff:

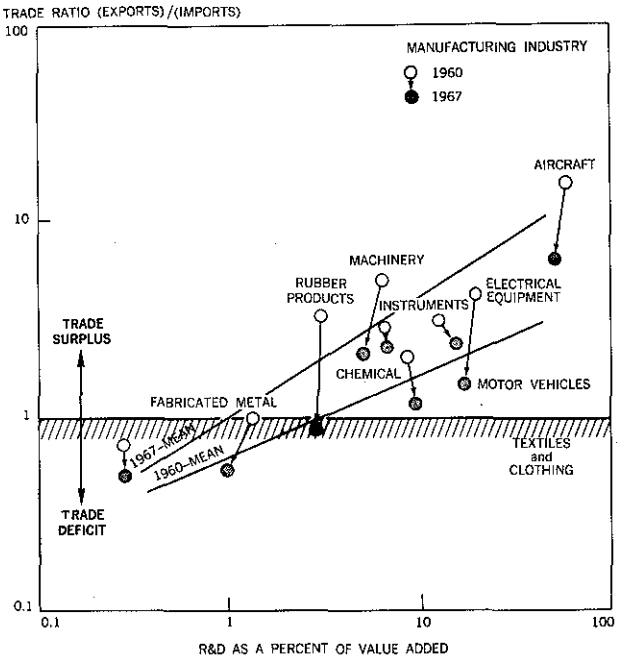
> The export strength of this country has always been in areas of high technology. Traditionally this country leads areas of new technology for a while. The second stage normally sees U.S. firms establish subsidiaries overseas to take advantage of lower labor costs. The third stage is imitation by indigenous entrepreneurs. It is a regular cycle which *must* be revitalized periodically by us taking the lead in new areas of technology or this country may become the Britain of 1980. Since the Government is the principal supporter of research, it has an obligation to plan sensibly to retain our lead.

Another set of data linking R&D to the balance of trade for specific U.S. industries is

presented in figure 5. This figure illustrates the improved trade ratio enjoyed by those industries expending high levels of R&D in terms of value added. The figure points out the trade ratio deterioration between 1960 and 1967 suffered by all industries, most of which spent less R&D in terms of value added. The mean lines indicate that our high-technology industries have lost their market position comparatively more than the low-technology industries.

In summary, it should be noted that we in the United States are presently able to pay ourselves between 3 and 5 times the rate of compensation which our counterparts in other parts of the world are able to justify. Our unique standard of living is derived directly from this differential. Other things being equal, extracting this level of personal profit would render us totally noncompetitive in the world market. Fortunately, other things are not equal. Up to now at least, the United States has been able to maintain a compensatingly higher rate of productivity. The term productivity as thus used includes not only manufacturing productivity in the usual sense but also innovative productivity. If the United States is to remain competitive, the balance between compensation and overall productivity must be maintained. Or, if the United States is to continue to enjoy the type of compensation benefits which it presently possesses, it must maintain its counterbalancing productivity advantage.

BALANCE OF TRADE vs. RATE OF R&D EXPENDITURE



Source: Calculated by the Commission from data in *Statistical Abstract of the United States.*

Figure 5

APPENDIX E

List of Recommendations

1. Conduct R&D procurement primarily to meet agency missions, but whenever possible be responsive to the needs of other Federal agencies and activities.

2. Allocate a limited amount of funds to each Federal laboratory to be used at the discretion of the laboratory director to initiate R&D projects in support of any national objective. Some of these projects might lie outside the normal mission of the laboratory.

3. Encourage, through the Office of Science and Technology, every Federal agency that has an R&D program in direct support of its missions and objectives to generate an associated program in long-range basic research and advanced studies and to support it at a level appropriate to the agency's needs.

4. Strengthen in-house capabilities to support technology advancement in the private sector, and specifically the procurement-related technical and management capabilities in laboratories by:

(a) Clarifying the assigned roles of the laboratories;

(b) Providing training and temporary assignment of technical manpower to intra-agency and interagency program management offices and regulatory bodies;

(c) Undertaking test and evaluation (T&E) of conceptual design, hardware, and systems that are proposed, designed, and built by private sources; and

(d) Maintaining technical competence by continuing to conduct basic and applied research and development projects.

5. Continue the option to organize and use FFRDCs to satisfy needs that cannot be satisfied effectively by other organizational resources. Any proposal for a new FFRDC should be reviewed and approved by the agency head and special attention should be given to the method of termination, including ownership of assets, when the need for the FFRDC no longer exists. Existing FFRDCs should be evaluated by the agency head periodically (perhaps every three years) for continued need.

6. Monitor the progress of the NSF/NBS experimental R&D incentives program and actively translate the results of this learning into practical agency application.

7. Eliminate restraints which discourage the generation and acceptance of innovative ideas through unsolicited proposals.

8. Eliminate cost sharing on R&D projects, except in cases where the performer of the project would clearly benefit, e.g., through economic benefits on commercial sales. Decisions with respect to the placement of R&D contracts or grants should not be influenced by potential involvement in cost sharing.

9. Eliminate recovery of R&D costs from Government contractors and grantees except under unusual circumstances approved by the agency head.

10. Recognize in cost allowability principles that independent research and development (IR&D) and bid and proposal (B&P) expenditures are in the Nation's best interests to promote competition (both domestically and internationally), to advance technology, and to foster economic growth. Establish a policy

recognizing IR&D and B&P efforts as necessary costs of doing business and provide that:

(a) IR&D and B&P should receive uniform treatment, Government-wide, with exceptions treated by the Office of Federal Procurement Policy.

(b) Contractor cost centers with 50 percent or more fixed-price Government contracts and sales of commercial products and services should have IR&D and B&P accepted as an overhead item without question as to amount. Reasonableness of costs for other contractors should be determined by the present DOD formula with individual ceilings for IR&D and B&P negotiated and trade-offs between the two accounts permitted.

(c) Contractor cost centers with more than 50 percent cost-type contracts should be subject to a relevancy requirement of a potential relationship to the agency function or operation in the opinion of the head of the agency. No relevancy restriction should be applied to the other contractors.

Dissenting Position 1

Dissenting Recommendation 10. Recognize in cost allowability principles that IR&D and Bid and Proposal expenditures are in the Nation's best interests to promote competition (both domestically and internationally), to advance technology, and to foster economic growth. Establish a policy recognizing IR&D and B&P efforts as necessary costs of doing business and provide that:

(a) IR&D and B&P should receive uniform treatment, Government-wide, with exceptions treated by the Office of Federal Procurement Policy.

(b) Allowable projects should have a potential relationship to an agency function or operation in the opinion of the agency head. (These will be determined in the negotiation of advance agreements with contractors who received more than $2 million in IR&D and B&P payments during their preceding fiscal year.)

(c) Agency procurement authorization and appropriation requests should be accompanied by an explanation as to criteria established by the agency head for such allowances as well as the amount of allowances for the past year.

(d) A provision should be established whereby the Government would have sufficient access to the contractor's records for its commercial business to enable a determination that IR&D and B&P costs are allowable.

(e) In all other cases, the present DOD procedure of a historical formula for reasonableness should be continued.

(f) Nothing in these provisions shall preclude a direct contract arrangement for specific R&D projects proposed by a contractor.

Dissenting Position 2

One Commissioner believes that in addition to the prime and dissenting recommendations advanced above, additional mechanisms exist which if explored adequately may offer reasonably acceptable solutions to the IR&D dilemma [see Chapter 4 for full text of his views].

11. Encourage the use of master agreements of the grant and contract types, which when executed should be used on a work order basis by all agencies and for all types of performers.

12. When a potential organizational conflict of interest exists and use of a hardware exclusion clause is proposed, require a senior official of the procurement agency to examine the circumstances for benefits and detriments to both the Government and potential contractors, and reach and justify his decision to contract with either no restraint, partial restraint, or strict hardware exclusion provisions.

Acronyms

AEC	Atomic Energy Commission
ASPR	Armed Services Procurement Regulation
B&P	Bid and Proposal
BOB	Bureau of the Budget
CITE	Contractor Independent Technical Effort
CODSIA	Council of Defense and Space Industry Associations
CWAS	Contractors Weighted Average Share in Cost Risk
DDR&E	Director of Defense Research and Engineering
DOD	Department of Defense
DODI	Department of Defense Instruction
DOT	Department of Transportation
DPC	Defense Procurement Circular
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAR	Federal Assistance Review (Program)
FCRC	Federal Contract Research Center
FFRDC	Federally Funded Research and Development Center
FPR	Federal Procurement Regulations
GAO	General Accounting Office
G&A	General and Administrative Overhead
GNP	Gross National Product
GOCO	Government-Owned, Contractor-Operated
GOGO	Government-Owned, Government-Operated
HEW	Department of Health, Education, and Welfare
HUD	Department of Housing and Urban Development
IAC	Industry Advisory Council
I&L	Installations and Logistics
IEEE	Institute of Electrical and Electronic Engineers
IR&D	Independent Research and Development
MAM	Management Analysis Memorandum
NACA	National Advisory Committee for Aeronautics
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NIH	National Institutes of Health

NSF	National Science Foundation
ODDR&E	Office of the Director of Defense Research and Engineering
OEO	Office of Economic Opportunity
OMB	Office of Management and Budget
ONR	Office of Naval Research
OSD	Office of the Secretary of Defense
OSRD	Office of Scientific Research and Development
OST	Office of Science and Technology
OTE	Other Technical Effort
RANN	Research Applied to National Needs
R&D	Research and Development
RFP	Request for Proposal
T&E	Test and Evaluation
T.D.	Treasury (Department) Decision
TEC	Technological Excellence Commission
U.K.	United Kingdom
USA	United States Army
USAF	United States Air Force
U.S.C.	United States Code
USN	United States Navy
VA	Veterans Administration

Part C—Acquisition of Major Systems

CONTENTS

CHAPTER 1

Directions for Change

This report treats a Federal procurement activity that has created controversy for two decades—the process of acquiring major systems, particularly the major systems of the Department of Defense.

The major system acquisition process draws upon new technology in developing new systems to meet national needs. Over the long term, defense acquisition programs represent a staggering commitment of national resources. The 141 programs currently identified in DOD, when complete, will have consumed a direct investment of more than $163 billion. Operating and maintenance costs over the lifetime of these systems could be two or three times greater than this aggregate direct investment.

Unlike many past studies that were constrained to deal with segments of the acquisition process, our study benefited from having an exceptionally broad congressional charter to examine system acquisition and to make recommendations for its improvement.

As a result, the Commission chose to take an integrated view of the acquisition process, covering all the basic steps from the initial statement of a need to the eventual use of a system. The report concentrates on the way the Government organizes policies and procedures to accomplish these basic steps. It also deals with the problems caused by the vested interests and motivations of the principal organizations in the roles they most often play in major system acquisition, including:

- *Contractors* who are overoptimistic in their estimates of system cost, performance, and delivery date and who make contractual commitments according to those estimates in order to win program awards.
- *Agency components,* like the military services, that reinforce contractor optimism to gain large-scale but premature program commitments in order to meet their obligations to provide modern operational capabilities and to preserve their stature and influence.
- *Agency heads* who do not have effective means of control in discharging their responsibilities for coordinating components and programs in the face of severe bureaucratic pressures.
- *Congress* and its committees which have become enmeshed at a detailed level of decisionmaking and review in attempting to fulfill their responsibilities. This disrupts programs, denies flexibility to those responsible for executing programs, and obscures Congress' view of related higher-order issues of national priorities and the allocation of national resources.

IMPROVING SYSTEM ACQUISITIONS

The need to improve major system acquisition has been made apparent by the succession of cost overruns, contract claims, contested awards, buy-ins, bail-outs, and defective systems that have drawn sharp criticism to one or more programs in recent years. The clutter of programs and problems has made it difficult to understand or grapple with the underlying causes of acquisition difficulties, some of which are subtly removed from the time and place that the symptoms appear.

This report concludes that the basic roadblock to improvements in system acquisition

is the fact that too many past attempts have addressed symptomatic problems, such as those just enumerated, on an individual, piecemeal basis. Patchwork corrective action has become counterproductive, leading to more regulations to amend regulations, more people to check people, more procedures to correct procedures, and more organizations to correct organizational problems.

Underlying Problems

Piecemeal improvements will only aggravate the underlying problem in system acquisition: *the lack of visibility over the key decisions that control the purpose and direction of system acquisition programs.* Without this visibility, these key decisions (and the information needed to make them) have been displaced from their proper organizational levels, both within Government and between Government and the private sector. The end results have been a diffusion of responsibilities that has made it difficult to control system acquisition programs.

Congress and agency heads have become so burdened with detail that they have not been effective in carrying out their respective responsibilities. Congress often cannot act as a credible and sensible check on an agency because acquisition programs provide no handles to enable Congress to interrelate the purpose of new systems and the dollars being spent on them with national policies and national needs. Instead, data is presented to Congress in "traditional" forms, inviting attention to already defined products and to annual budget increments that finance development and production. From many points of view, this information is useless as a basis for effective congressional review.

The agency head has a similar problem. He cannot manage or control agency components unless he makes some key program decisions to keep cost and capabilities within coordinated agencywide limits. Agency components often start and carry out major system acquisitions with little or no control by the agency head or Congress because responsibility for making some key decisions is unclear. However, once such decisions are made, an acquisition program is set on a course that is costly, if not impossible, to change without outright cancellation.

Finally, the responsibility for making decisions on new system products has been spread across the public and private sectors, badly distorting the buyer-seller relationship between the Government and contractors. This has precluded effective competition and undermined contractual agreements.

Main Directions for Change

The Commission's recommendations in effect call for a "systems approach" to solving the problems of major system acquisition by:

- Establishing a common framework for conducting and controlling all acquisition programs that highlights the key decisions for all involved organizations—Congress, agency heads, agency components, and the private sector.
- Defining the role each organization is to play in order to exercise its proper level of responsibility and control over acquisition programs.
- Giving visibility to Congress and agency heads to exercise their responsibilities by providing them with the information needed to make key program decisions and commitments.

Congress and agency heads must exercise their responsibilities by participating effectively in key acquisition decisions that steer a program and determine which national problems are met; determine how successful agencies will be in performing their missions; and influence long-term patterns in the use and allocation of national resources. To participate effectively requires that meaningful information be brought forward for deliberation. Decisions on needs, goals, the choice of a system, and commitment of development and production resources must be presented in a clear and cohesive framework that can be referenced by all parties involved.

Our report recommends a realignment of the acquisition structure to correct the de facto abdication of responsibilities in Govern-

ment and industry that has come about for want of a clear understanding of the decisions and actions that actually control system acquisition programs. The need to reestablish control and reallocate responsibilities is vital not just for defense programs but also because system acquisition programs will be used increasingly throughout the Government to meet civilian as well as defense needs.

Because this report is based on an integrated view of the acquisition process, the recommendations made are linked to form a structure that is applicable for acquisition programs of all agencies. Recommendations are not designed to be applied selectively to improve parts of the acquisition process but, rather, to work together to control the whole. The recommended structure is shown in figure 1 with the key recommended actions that will be discussed later in this summary chapter and more fully in the detailed report.

Expected Results and Implications

The recommended actions would establish effective control over system acquisition programs—what they are supposed to do and how much we are willing to pay for them—before these things are decided, often by default, by the systems and their government and industry sponsors.

In the long run, adopting the recommendations should also result in a net reduction in the time and cost to go from the statement of a need to the effective use of a system to meet it. This is to be accomplished not by shortening or paying less for every phase of activity but by spending more time and money on the early pivotal development tasks that will net savings in the larger commitments that follow. Less time and money should be spent on nonproductive activities that service the demands of the bureaucracy and its regulations but do little to increase our information about what system to buy or to advance the development of a satisfactory system.

The recommendations also suggest a different environment for the participating institutions because:

Congress must become a more effective and informed check and balance in acquisition programs through the use of its legislative prerogatives. Congress should be given the opportunity and information to understand the need and goals for new programs in the context of national policy and priorities. Thereafter, they should be in a better position to monitor the development, procurement, and operating funds going to programs to meet these needs.

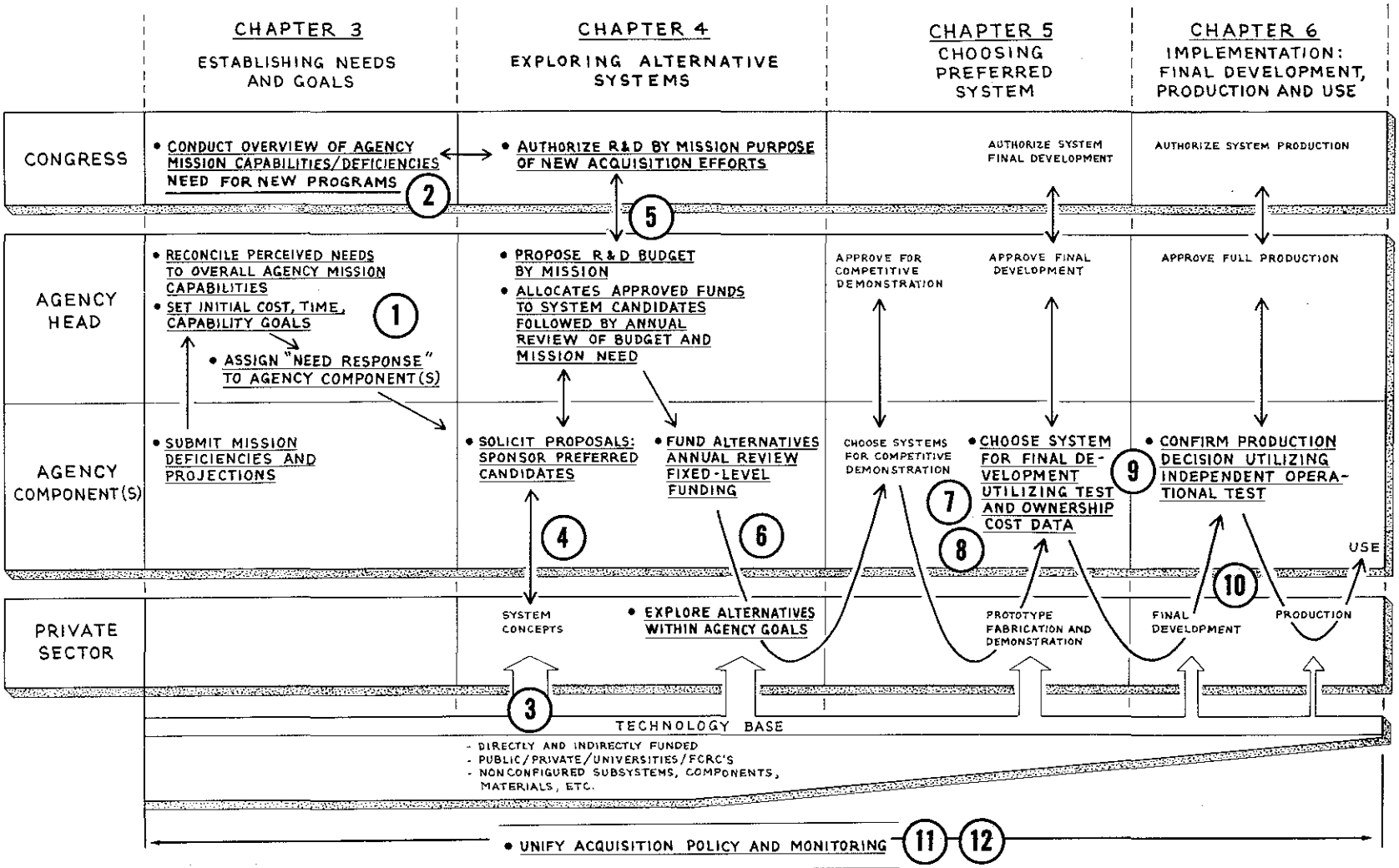
Agency heads must make early decisions on program needs and coordinate the responsibilities of agency components. The agency head should make the decision to initiate a program to provide increased mission capability and set a cost goal in view of all related agency needs and resources. Thus, programs would not be initiated independently of total agency capabilities, needs, and resources. The agency head would also reconcile needs with the mission responsibilities of agency components, assuring that if component rivalry leads to duplicate efforts, the duplication is purposeful, visible, and controlled.

Agency components must be given full flexibility to explore alternative systems within agreed-upon program goals before committing to just one. With this flexibility, their management efforts would shift from designing a system and controlling its development to management based on review, test, and evaluation of competing private sector design efforts.

Contractors must enter a competitive arena that rewards suppliers who are held responsible for creating and demonstrating the best system according to their own business and technical judgments. Competition should involve innovative products that must demonstrate that they meet the Government's need at the lowest cost, not an undeveloped but already defined system at the price needed to win. On this basis, new firms would be allowed to enter and old ones forced to exit from an industry whose total capacity would be based on current and future system needs.

Overall, the report calls for a simplified but flexible decisionmaking process that places greater reliance on sound judgment and less on regulations and complicated contracts and clauses. It also recommends that acquisition

MAJOR SYSTEM ACQUISITION
• RECOMMENDED ACTIONS



Source: Commission Studies Program.

Figure 1

policy and monitoring be unified within each agency with a concurrent reduction in management and administrative layering between policymakers and program offices, and a counterpart reduction in industry staffing.

OVERVIEW OF REPORT AND RECOMMENDATIONS [1,2]

Major system acquisition is an extended and complex process. It begins with the Government's determination that a certain capability needs to be strengthened and the premise that the technological base can support viable system concepts. It continues through development, production, and operation of a system to meet that need, with information flowing back at each stage to those who are responsible for comparing what exists with what is needed.

Well-known major systems are the space shuttle, Apollo spacecraft, Minuteman missile, Polaris fleet ballistic missile system, C–5A transport, F–14 and F–15 fighter aircraft, Phoenix and SAM–D missile systems, Main Battle Tank, and Cheyenne helicopter. Hundreds of other major systems have been developed, many with lesser unit costs but in greater production quantities.

Evolution of Practice and Problems

Most difficulties in major system acquisitions, including cost overruns and overly sophisticated, expensive systems, arise from a few basic characteristics of the way Federal agencies have come to organize system acquisition programs and engage private sector participation. The evolution of the system approach—a comprehensive attack on a problem in the context of its total environment—has caused radical changes in the Government procurement process.

Until after World War II, the usual practice was to develop and produce many system components and subsystems independently of their integrated use in a weapon system. The design of many major weapon systems was sufficiently stable to permit components and subsystems to be readily integrated. The military services were, in effect, buying major systems in bits and pieces.

Following World War II, there was greater awareness of the benefits that might be gained if advancing technologies could be stimulated and brought together to meet the escalating Cold War needs for national defense. But the new technologies presented problems. Each new component or subsystem, although it offered improved characteristics, had to work well with other new pieces in order for the total system to be effective. This called for stronger control over all the newly developing components and subsystems and the system itself.

The size of the emerging programs brought about a shift in Government-industry relationships so that the benefits of the system approach were not without some drawbacks. Companies could not be expected to develop major systems and subsystems on their own without the assurance that they would be able to sell enough of their products to recover development costs. The funds required and the technical risks involved were too great. As a result, an agency had to underwrite the development of new major systems.

DOD was the first to face these unusual buyer-seller conditions as it took the lead in developing the major system approach to meet defense needs. Although particular program practice varied in significant degree, the following is the general process that crystallized in the 1960's and remains the predominant pattern for communicating the Government's need, creating a system, and contracting for it.

The process began with a decision within one of the military services that its ability to perform an assigned mission should be strengthened by a new system. Policy and practice usually excluded the Office of the Secretary of Defense (OSD) and Congress

[1] Appendix B is a compilation of the 12 recommendations made in this part of the report.

[2] In the discussion and recommendations that follow, "agency" refers to each executive department or agency whose head reports to the President, such as DOD and DOT. "Agency component" refers to the first major organizational divisions within the agency below the agency head, such as the military services and the Federal Aviation Administration. "Agency mission" refers to a function to be performed by the agency, either generally or specifically, in support of the agency's assigned responsibilities.

from these early deliberations on the need for a new system, although the military services were guided by Department of Defense plans and policies.

The agency would begin to describe the system so that it could contract for its development. The need would be communicated informally to industry, usually in terms of a product better than one currently doing the job. Goals typically would be for better system performance, such as more range and speed or less size and weight.

Companies would respond with their ideas on new systems, sometimes presenting different system concepts. The system concept that offered the most promise and was most compatible with the service's interest and operating doctrine had the best chance of being selected. The information used to select the concept and technical approach for development could come from industry (both informally and under study contracts) and from within the agency's own laboratories and technical staffs. The most desirable features received from these various sources, many of which required advances in the state-of-the-art, usually would be combined into a total system description.

After the agency component had decided on the system concept and main technical features, a detailed system description would be issued to solicit industry proposals in formal competition for the award of the development contract. Upon receiving contractor proposals, the agency again would pick up the most attractive ideas, weave them into an updated system description, negotiate with the most promising contractors, and ultimately select one to develop and produce the system. The system often was an amalgamation of ideas from many Government and industry sources; no single public or private sector organization had the scope or depth of engineering knowledge to know if the system actually could be developed to perform as intended within planned time and dollar limits.

The agency often found it difficult to choose a clear technical winner because the technical approach and all main system features had been specified by the agency. The point scorings used to judge competitors often were close and awards sometimes were contested. Price or estimated cost dominated final evaluation and pressured contractors to "buy-in" with a low price bid for an undeveloped system. A company's survival hinged, in large measure, on winning one of these major programs in which an increasingly large proportion of new military expenditures were being concentrated. Even if the agency could predict that it was accepting a "buy-in" price, realistically it could not justify paying a price higher than a major, experienced contractor had proposed and was willing to accept.

The winner of this so-called "design competition" received a contract to conduct a development phase that might span five years. Sometimes the contract would include production.

The date for a new system to become operational would be influenced by the desire to field it as soon as possible and the assumption that everything would proceed according to plan. Contractors would agree to this date in response to the terms and conditions of the competition. This often would necessitate starting production before the development and testing were completed (concurrency) and building up large organizations very quickly to handle all phases of a compressed development and production program with little room for learning or mistakes.

Some years later, when all did *not* go according to plan, the system did not measure up to initial expectations and costs grew unexpectedly. The contractor could be blamed for poor management of the development effort. In turn, the contractor could shift blame to the agency for imposing what turned out to be an inconsistent or impossible set of technical requirements on the system and for having forced premature performance, schedule, and pricing commitments under the heat of contrived competition.

At this point, the agency would find itself doing business with only one contractor with the background needed to carry out the protracted test and production phases. In this situation, the agency could not abdicate its responsibility to meet real defense needs or disregard the public funds already invested in the system; the agency often had to find ways to "bail out" the contractor from his technical and financial difficulties.

Pressure grew for increased agency en-

gagement and control over system developments. Methods were developed within the Government to control the technical and management functions of both contractor and in-house organizations. The results have been a proliferation of staffs and multiple levels of review in both industry and Government; a proliferation of paperwork, management systems, and regulations; demands for much greater program detail by Congress; and increased reviews of major systems by the General Accounting Office. The proliferation of controls has contributed to many of the symptomatic problems and complaints reported in recent years by various Government, industry, and public sources.

Some of the most important problems discussed are summarized in the first column of table 1. DOD has recently made efforts to improve system acquisition practices, as shown in the second column, and has begun to implement its plans on some selected new programs. The third column highlights the changes recommended here that generally support recent DOD actions, but also extend into more fundamental aspects of the acquisition process. They should not be evaluated on an individual basis but as part of the

TABLE 1. COMPARISON OF PAST PROBLEMS, CURRENT CHANGES, AND RECOMMENDED ACTIONS (Department of Defense)

PAST PROBLEMS	*MAJOR CURRENT CHANGES (Others discussed in text)*	*MAJOR RECOMMENDED ACTIONS (Others discussed in text)*
ESTABLISHING NEEDS & GOALS		
• Needs/goals set by each service; unplanned duplication	• Mission area coordinating papers	• Agency head reconciliation of needs/goals and service responsibilities
• No formal congressional overview		• Congressional review of mission deficiencies, needs/goals for new acquisition programs
EXPLORING ALTERNATIVE SYSTEMS		
• Centralized agency-level control over systems	• Decentralization; more authority for military services	
• Lack of congressional visibility; scattered R&D line items		• Congressional authorization and appropriation of RDT&E funds for systems candidates by mission need
• Premature commitment to single technical approach	• Attempt to broaden choice of system options at first agency-level review	• Solicit system proposals using broad need statement; maintain integrity of separate candidate systems
• Multiple information sources; uncommitted industry proposals; pressures for goldplating; high unit costs		• Annual review and fixed-level awards to each selected competitor; agency technical staff assistance
• Narrow technical latitude for competition; paper information; buy-ins	• Greater design latitude; more time for exploration and hardware development	• Commit best competitors to prototype system-level demonstration
CHOOSING PREFERRED SYSTEM		
• Paper competition; complicated source selection; contentious awards	• Some hardware prototypes; less reliance on paper	• Choose system based on mission performance measurements, total ownership costs derived from competitive demonstration and operational tests
• Single contract covering both development and production	• No "total package" awards	
IMPLEMENTATION		
• Overlapped development and production ("concurrency")	• Reduced concurrency	• Independent operational test before full-production release; strengthened test organizations
• Late and inadequate operational tests for production decision	• Emphasis on early and better operational testing	

Source: Commission Studies Program.

acquisition structure presented earlier in figure 1.

The recommended acquisition structure does not eliminate the need for competent personnel to exercise sound judgment. It highlights the fundamental decision points that must be dealt with by each agency as a system moves through the acquisition process. It also identifies the kind and quality of information that should be available when each decision is made.

The acquisition structure is recommended as the best standard for conducting the process, but it is designed to be flexible. Intelligent and well defined variations can be made while achieving the necessary visibility and control. Standards for the most important variations and the responsibilities for authorizing such variations are presented in this chapter.

Establishing Needs and Goals

STARTING AND COORDINATING PROGRAMS

Establishing needs and goals for a new acquisition program is one of the most vital areas for improving system acquisition. Decisions on needs and goals have far-reaching effects on the formulation and direction of national policies and strategies. The resources required to develop major systems are a significant factor in an agency's total budget and in the allocation of funds among Federal agencies and components. In view of the resources consumed by major programs, the needs to be met and the goals to be achieved must receive close attention from the agencies and Congress. Both defense and civilian programs have suffered when well-defined and coordinated statements of needs and goals were lacking.

Program goals establish the capability needed, the money that can be spent to get that capability, and the date for achieving it. These goals set the tone of the program. Allowing one goal to improperly dominate may cause later distortions such as when urgency receives unwarranted emphasis, leading to compressed development and production activities.

Great sums have been committed to programs which, later, cannot respond to corrective changes in goals. Programs often have been begun with insufficient consideration of other programs underway that can collectively strain the limits of existing resources. Lack of additional funds requires a cutback in the number of systems, leaving unplanned disruptions in an agency's capability to do its job.

DOD policy currently delegates the responsibility for deciding needs and goals to each of the military services. They define them mainly in terms of the kind of hardware they "need," not in terms of the mission to be performed. Although new technological opportunities cannot be ignored, too often the focus has been on the system product and not on its purpose. The results have been pressures to lock-in to a single-system approach prematurely without giving adequate attention to why a new level of capability is needed in the first place and what it is worth before less costly system alternatives are created or eliminated.

The needs and goals that each military service sees for its acquisition programs are shaped by its own views of defense missions and priorities. They do not necessarily correspond to the perceptions of the other services or of the Office of the Secretary of Defense, frequently resulting in destructive interservice rivalry and overlaps in mission capabilities. Interservice rivalry has caused special complications for system acquisition programs because these programs have become the principal means by which the services can preserve and enlarge their roles, budgets, and influence.

Interservice rivalry can be made to work to advantage if harnessed by a clear statement of common needs, an invitation for the services to compete openly when appropriate, and a formal recognition that we cannot afford to finance all the systems sponsored by each of them. The objective should not be to eliminate all overlap or duplication in assigned responsibilities among or within the services; it should be to ensure that where such overlap or duplication exists, it is visible, controlled, and purposeful.

DOD has attempted to view new systems and programs on an agencywide basis through its mission Area Coordinating Papers (ACPs)

but they do not carry the weight of secretarial decisions or apply to the very start of new acquisition efforts. Unplanned duplication of systems; pressures to make new systems large, multipurpose, and expensive; premature commitments to an undeveloped system; and loss of control over the allocation of resources to agency missions all result when programs are begun independently by agency components to obtain "needed" products without agencywide coordination of needed capabilities and affordable costs.

Recommendation 1. Start new system acquisition programs with agency head statements of needs and goals that have been reconciled with overall agency capabilities and resources.

(a) State program needs and goals independently of any system product. Use long-term projections of mission capabilities and deficiencies prepared and coordinated by agency component(s) to set program goals that specify:

(1) Total mission costs within which new systems should be bought and used

(2) The level of mission capability to be achieved above that of projected inventories and existing systems

(3) The time period in which the new capability is to be achieved.

(b) Assign responsibility for responding to statements of needs and goals to agency components in such a way that either:

(1) A single agency component is responsible for developing system alternatives when the mission need is clearly the responsibility of one component; or

(2) Competition between agency components is formally recognized with each offering alternative system solutions when the mission responsibilities overlap.

CONGRESSIONAL REVIEW OF NEEDS AND GOALS

Without a clear understanding of the needs and goals for new programs, Congress is unable to exercise effectively its responsibilities to review expenditures and the allocation of national resources. This failure is partly encouraged by the timing and format used to present system acquisition programs and by the kinds of questions this format provokes. The wrong questions are asked early about research and development projects and, when the right ones are provoked by debate on a particular system, it is often too late for the answers to be relevant.

Current budgeting and review procedures expose the need and goals for a program to Congress at a time when a single system is proposed, with cost, schedule, and performance estimates often predicated on insufficient research and development efforts. At this stage, it is difficult to control costs because system characteristics are fixed within a narrow range. Thus, the cost to meet a mission need is largely determined by the cost of the new systems, not the worth of the new mission capability compared to other alternatives. This leaves Congress a futile choice: either pay the price for the system or let the need go essentially unsatisfied. Congressional ability to deal with agency budgets and to provide meaningful guidelines to allocate limited national resources is seriously undermined.

Congress should have an early and comprehensive opportunity to debate and understand any agency's mission needs and goals for new acquisition efforts, and the opportunity to discuss the relationship of proposed mission capabilities to current national policy and the allocation of resources in accordance with national priorities. Understanding an agency's needs and program goals before discussing the system to meet the need should help reduce the delays in authorization and appropriation caused by extended investigation of all these issues when a system surfaces later for large-scale funding approval.

This does not imply that Congress should make defense strategy, define defense missions, or interpret for the military what their needs are and the best way to meet them; these are roles of the executive branch. Congress *should* have the opportunity to review agency programs in such a way that the programs can be clearly related to national policies, priorities, and the allocation of resources

in order for Congress to exercise its legislative responsibilities and controls. This is preferable to having the consideration arise after a single system is well into development, when need and goals are already obscured by the technical merits and demerits of a particular system, and there is little room to control the cost of meeting national needs.

Recommendation 2. Begin congressional budget proceedings with an annual review by the appropriate committees of agency missions, capabilities, deficiencies, and the needs and goals for new acquisition programs as a basis for reviewing agency budgets.

Exploring Alternative Systems

THE TECHNOLOGY BASE [3]

Ongoing exploration of technology is fundamental to any new acquisition program—new components, tools, materials, processes, and organized knowledge can be used to develop new and better ways to meet public needs. The chances for success of any major system acquisition are enhanced if there is a variety of advancing technologies from which new system solutions may be drawn. Otherwise, a solution must be based on a safe but stagnant technological choice or on unpredictable advances outside that range.

Most Federal agencies with operating responsibilities recognize the value of a strong technological base. For example, the most recent defense policy on major system acquisition cites the importance of "a strong and usable technology base" to provide raw material for creating more effective and less costly systems.

There is no way to know how much money to spend in a given field of technology; the payoffs are usually unpredictable and downstream in time. Technology is advanced through a creative process sparked by dedicated people in Government, industry, and universities, supported directly by contracts, grants, or industry profits, or indirectly through recovery of related overhead costs.

[3] This subject is also treated in Part B (Acquisition of Research and Development).

Technical judgment is the critical factor in apportioning money and in performing this kind of effort. The results may not be immediately useful and may have unforeseen applications of unpredictable value.

The Government has paid a spiralling cost to meet growing public needs by stretching existing technology and "goldplating" old approaches instead of seeking innovative approaches that ultimately might prove less complex, less costly, and more effective. This is a case of diminishing returns: to do a job 10 percent better may cost 50 percent more if the old technology is stretched. Sometimes this approach is selected simply because of time or initial dollar constraints.

Maintaining an adequate growth of technology is one of the most important prerequisites for successful system acquisition, but there have to be limits on activity that is financed and justified solely for its value to the base of technology. Currently, the technology base is inadequately developed to support new acquisition programs and their search for candidate systems.

Technology base work (both public and private) tends to concentrate on producing results that are, first, immediately useful and, second, acceptable. To be useful, the work tends to provide well-developed products (both subsystems and system concepts) before the need for any has been established and confirmed at the agency level. To be acceptable, these products tend to be based on familiar approaches. The search for alternatives in connection with a specific operational need frequently is conducted in a way that nourishes the technology base in constrained areas of relatively "old" technologies. The net effect is a closed cycle; innovative technologies are suppressed and relatively stagnant ones are carried too far as subsystem and system candidates in anticipation of a specific program.

The Commission favors making the technology base better serve new programs by (1) controlling how far projects are taken within technology base funding and justification and (2) giving the base a greater access in offering new system candidates.

Recommendation 3. Support the general fields of knowledge that are related to an agency's assigned responsibilities by fund-

ing private sector sources and Government in-house technical centers to do:

(a) Basic and applied research

(b) Proof of concept work

(c) Exploratory subsystem development.

Restrict subsystem development to less than fully designed hardware until identified as part of a system candidate to meet a specific operational need.

CREATING NEW SYSTEMS

In the face of uncertainties about needs and technology, it makes sense to explore alternative systems. At the start, it is more expensive to explore several approaches than to focus quickly on one. However, the short-range cost should be weighed against the long-term benefits of having options, particularly in the early phases of development when they cost relatively little. Money spent on development of alternative systems can be relatively inexpensive insurance against the possibility that a premature choice of one approach may later prove to be a poor and costly one.

In addition to guarding against uncertain needs and technology, alternative systems also:

- Provide a means for introducing the benefits of competition in the early stages of system evolution when the cost to maintain competitors is only a small fraction of that needed to have competition in later full-scale development and production phases
- Insure that a wider base of innovative talent is applied rather than concentrating R&D resources on a single-system approach
- Increase the probability that the best possible solution will be found.

DOD acquisition procedures have not worked well in surfacing system alternatives based on different technical approaches. This fact is evidenced by ongoing consideration of new policies to foster more substantive system options and to improve the quality of information at the first program review at the Secretary of Defense level. Despite these efforts, research and development funds remain generally scattered in a great many separate projects, making it difficult to trace the cost or existence of alternative systems prior to the first agency head review of a new program.

Premature commitment to system concept, technical approach, and design often leads to cost growth, performance shortfalls, and schedule delays. The combined pressures of (1) limited resources to explore alternatives and (2) the requirement that the military services defend a system before large-scale resources are committed create incentives for them to focus prematurely on one technical approach. Resources are spent to prove that the initial choice is right in order to get a go-ahead decision, rather than to examine broad alternatives.

Military services also become advocates of specific methods and approaches to meet their responsibilities. This advocacy is dedicated to fielding the best solution to mission deficiencies based on *past* operational experience. Such advocacy leads to parochial choices of familiar kinds of systems.

To encourage a greater number of more innovative alternative systems to meet a given need, DOD requests for proposals should be broadly stated in terms of needed mission capability, program goals, and essential limitations, not in terms of required features or performance stipulations keyed to a particular kind of system.

There is a critical need to capitalize to a greater degree on the Nation's innovative resources by encouraging smaller firms to enter early in the acquisition process, provided they can make necessary business arrangements for plant and facilities if their proposed systems prove superior.

Large, established firms tend to acquire technical biases based on their experience with successful products and their customer's tastes. Smaller, growing firms are more likely to have more initiative and innovative technical approaches for new systems. However, large firms are usually the only ones considered qualified to compete for major system development awards because competitions are held relatively late in the process, at great expense, after system performance and design features have been determined.

There is a need to balance the acquisition

process by ensuring a more objective selection and exploration of alternative systems. The agency should also prevent centralization of the management process and the buildup of large staffs to do the job that should be done at the operating level. The Commission favors retaining the decision on which system alternatives to explore at the agency component level but with reviews to ensure that alternatives are created and explored.

Recommendation 4. Create alternative system candidates by:

(a) Soliciting industry proposals for new systems with a statement of the need (mission deficiency); time, cost, and capability goals; and operating constraints of the responsible agency and component(s), with each contractor free to propose system technical approach, subsystems, and main design features.

(b) Soliciting system proposals from smaller firms that do not own production facilities if they have:

(1) Personnel experienced in major development and production activities

(2) Contingent plans for later use of required equipment and facilities.

(c) Sponsoring, for agency funding, the most promising system candidates selected by agency component heads from a review of those proposed, using a team of experts from inside and outside the agency component development organization.

CONGRESSIONAL REVIEW OF SYSTEM EXPLORATION

Congress has difficulty overseeing the growing expenditures for agencies' R&D budgets; its intensified demands for information and justification leaves Congress burdened with detailed reviews that obscure the overall pattern.

Congress could better understand where R&D money is spent if it reviewed, authorized, and appropriated funds for exploring candidate systems according to mission. This should be done in conjunction with its review of agency missions and the needs and goals for new acquisition programs. This approach would segregate funds for (1) maintaining the technology base, (2) activities to explore alternative solutions to mission needs, and (3) the final development of systems chosen to meet needs. The second category would group together all development projects associated with candidate systems to meet each agency mission need. Congress would then have a more meaningful and convenient basis for reviewing expenditures and earlier awareness of the evolution of new systems.

Allocations of R&D money according to mission needs would help reduce the pressures to make premature commitments to a particular system in order to gain funding approval. With defense mission needs and goals reviewed yearly, and with a fixed-level funding constraint tied to finding solutions, the executive branch would have greater flexibility to explore alternative systems and cope with uncertain system candidates. The opportunity to question and review individual projects within these mission funds would remain whenever such scrutiny is needed but, at the same time, a more meaningful level of review and control would be available.

There is a growing awareness in Congress that it must deal more effectively with executive branch programs and equip itself more fully to do so. The primary intent of our recommendations on review of program needs, goals, and related funds is to sharpen the effectiveness of whatever congressional efforts are expended to review major system acquisition programs.

Recommendation 5. Finance the exploration of alternative systems by:

(a) Proposing agency development budgets according to mission need to support the exploration of alternative system candidates.

(b) Authorizing and appropriating funds by agency mission area in accordance with review of agency mission needs and goals for new acquisition programs.

(c) Allocating agency development funds to components by mission need to support the most promising system candidates. Monitor components' exploration of alternatives at the agency head level through annual budget and approval reviews using updated mission needs and goals.